
Preparing 2002 Regional PM_{2.5} Emission Inventories

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What We'll Cover...

- PM2.5 Overview
- Inventory Development in General
 - NEI purpose and process
 - Tools
 - Key Issues
- Improving PM2.5 Inventories
 - Fugitive Dust
 - Combustion
 - Ammonia
- Q & A, Comments and Requests, Etc.

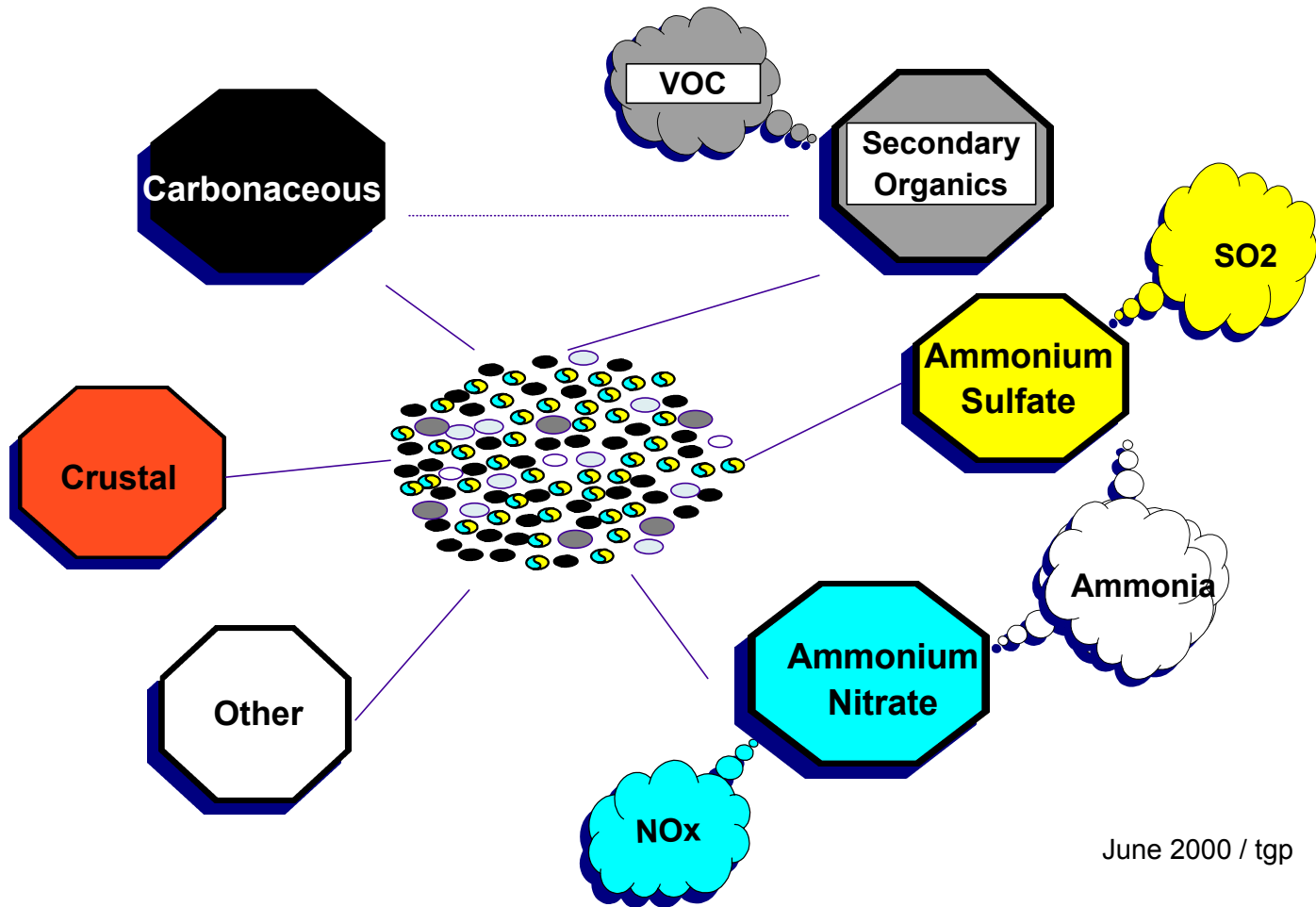
Preparing 2002 Regional PM2.5 Emission Inventories

PM2.5 Overview

PM 2.5 In Ambient Air - A Complex Mixture

Primary Particles
(Directly Emitted)

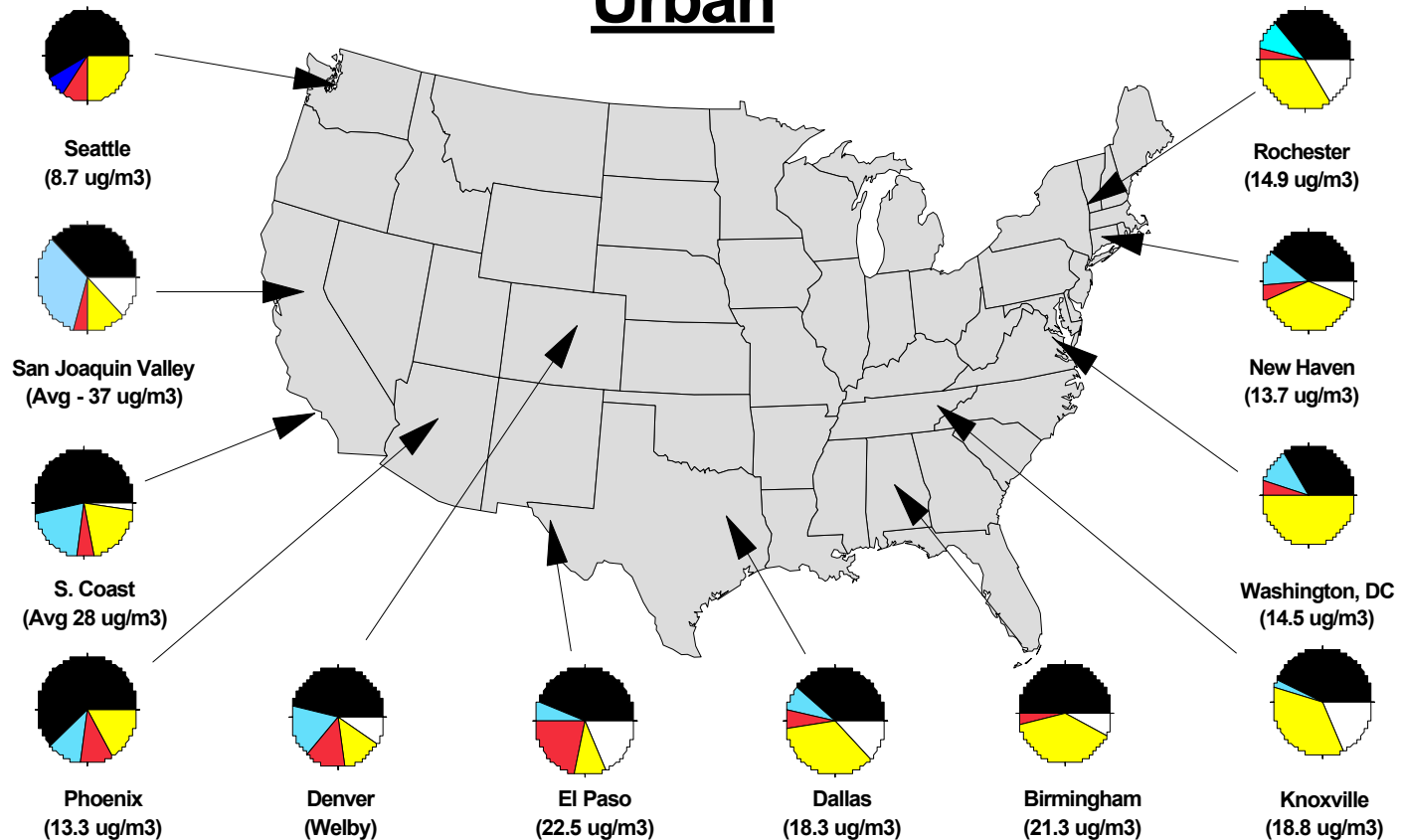
Secondary Particles
(From Precursor Gases)



PM2.5 Ambient Composition



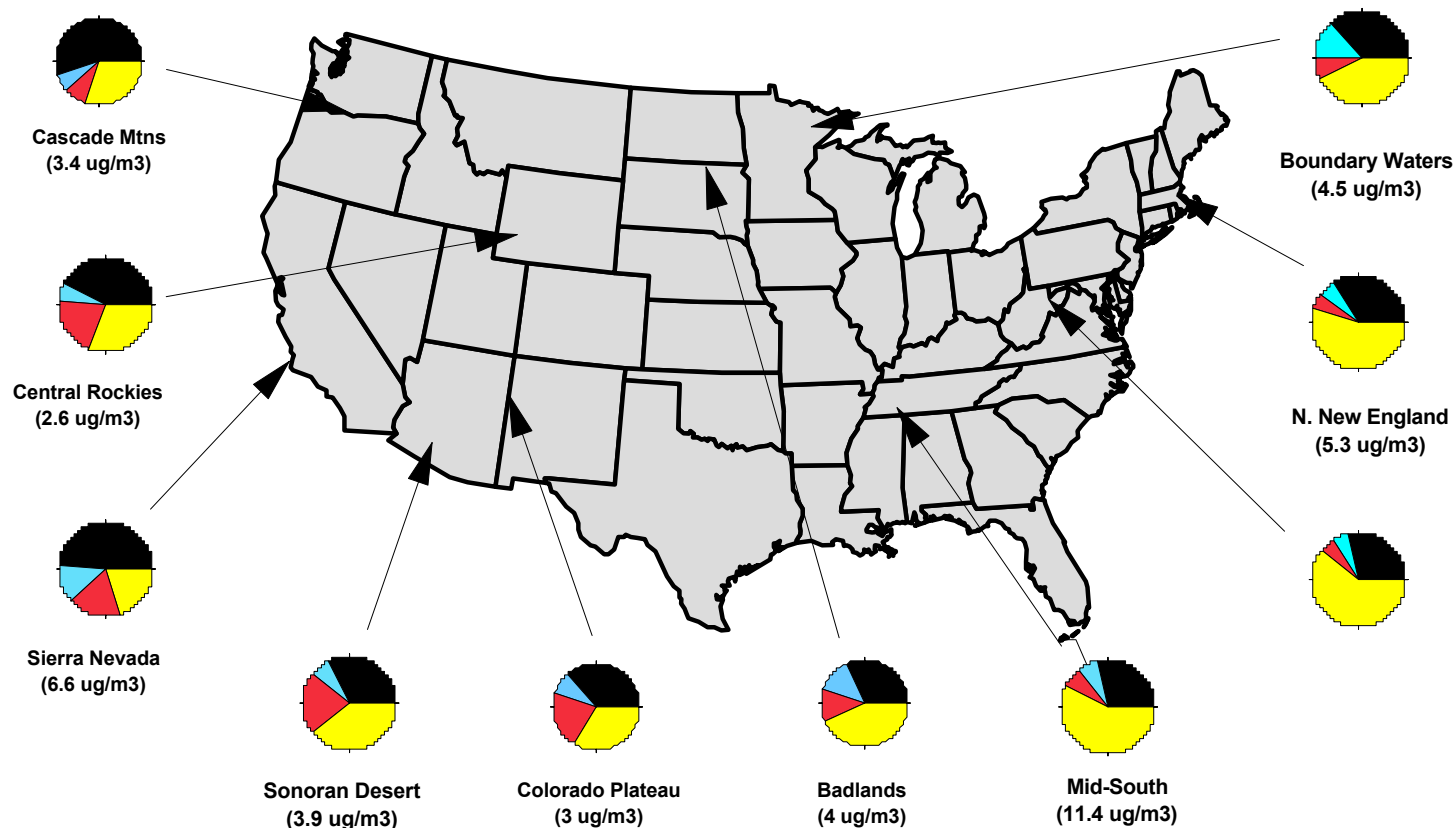
Urban



PM2.5 Ambient Composition



Non Urban



Note: PM-2.5 mass concentrations are determined using at least 1 year of monitoring at each location using a variety of sampling methods. They should not be used to determine compliance with the PM-2.5 NAAQS.

Important PM2.5 Source Categories

DIRECT EMISSIONS

Combustion

a, b

- **Open Burning (all types)**
- **Non-Road & On-Road Mobile**
- **Residential Wood Burning**
- **Wildfires**
- Power Gen
- Boilers (Oil, Gas)
- Boilers (Wood)

Crustal / Metals

b

- Fugitive Dust
- Mineral Prod Ind
- Ferrous Metals

PRECURSOR EMISSIONS

SO₂

c

- **Power Gen (Coal)**
- **Boilers (Coal)**
- Power Gen (Oil)
- Boilers (Oil)
- Industrial Processes

NO_x

- **On-Road Mobile (Gas, Diesel)**
- **Power Gen (Coal)**
- **Non-Road Mobile (Diesel)**
- **Boilers (Gas)**
- Residential (Gas, Oil)
- Industrial Processes

NH₃

- **On-Road Mobile**
- **Animal Husbandry**
- **Fertilizer Application**
- Wastewater Treatment
- Boilers

VOC

d

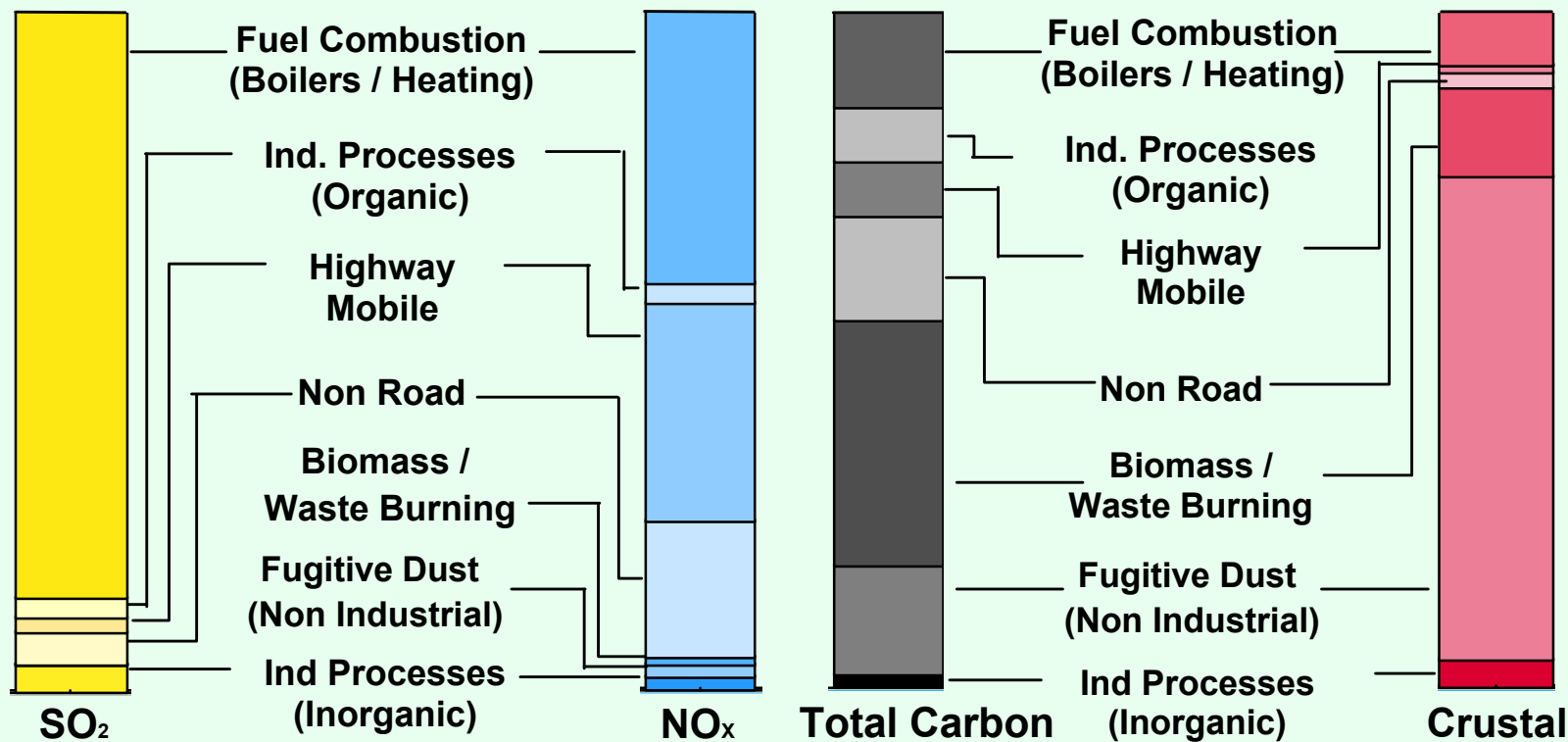
- **Biogenics**
- **Solvent use**
- **On-Road (Gas)**
- Storage and Transport
- Residential Wood
- Petrochemical Industry
- Waste Disposal

- a Includes primary organic particles, elemental carbon and condensable organic particles; also some flyash
b Impact of carbonaceous emissions on ambient PM 5 to 10 times more than crustal emissions impact
c Includes SO₂ and SO₃ and H₂SO₄ condensable inorganics
d Contributes to formation of secondary organic aerosols

NOTE: Categories in **BOLD** are most important nationally. Their relative importance varies among and between urban and rural areas.

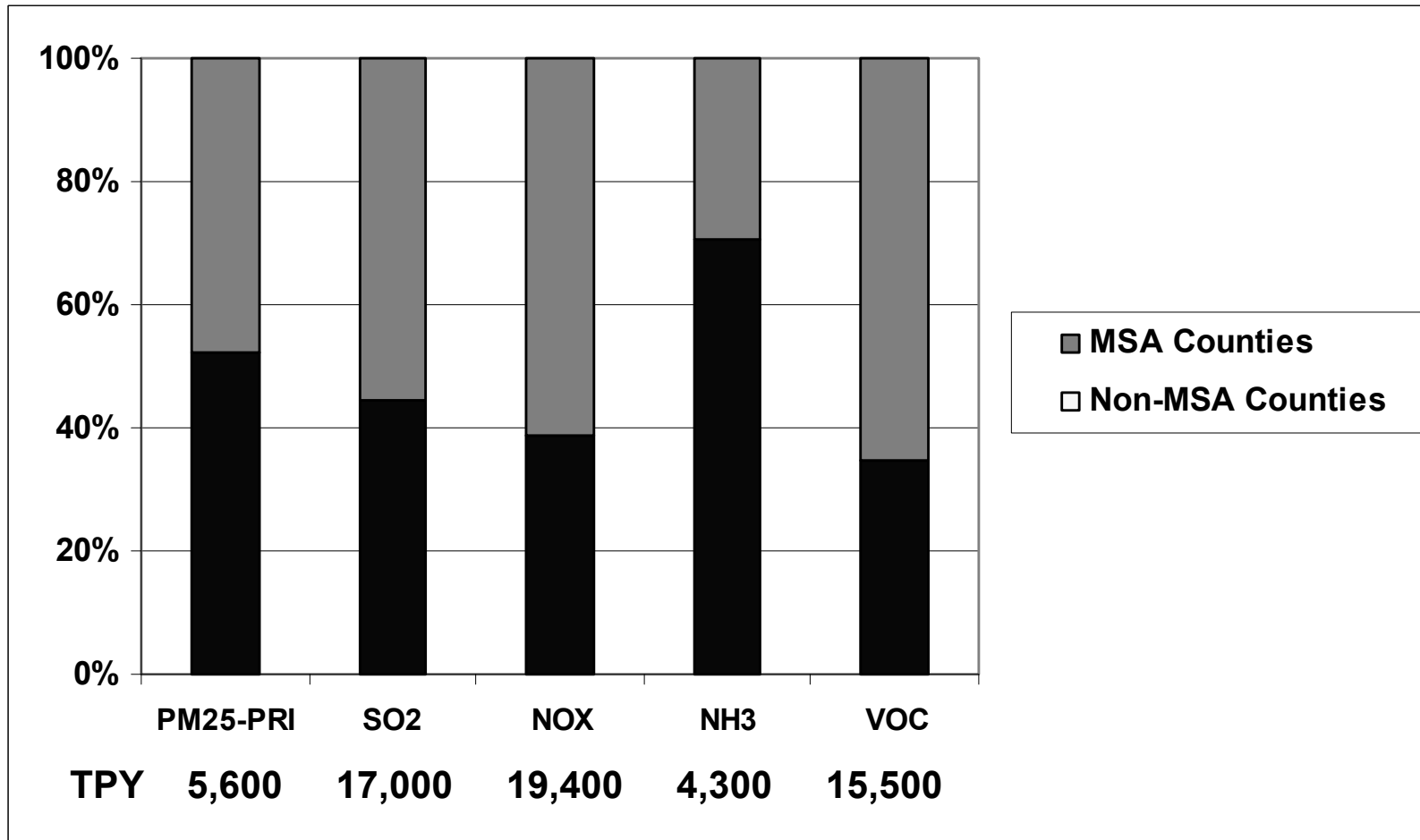
Sources of PM_{2.5} (after Speciation)

PM_{2.5} National Emissions Summary



37-State^(+DC) Emissions in NEI, 1999

(MSA - Non MSA Comparison)



Preparing 2002 Regional PM_{2.5} Emission Inventories

Inventory Development in General

NEI: Purpose and Process

- **What is the NEI and Why do we have it ?**
- **How is the NEI Developed ?**
- **What Are the Important Sources of PM_{2.5} & its Precursors ?**
- **Inventory Development Tools**
- **Uncertainties**
- **Key Issues in the NEI**

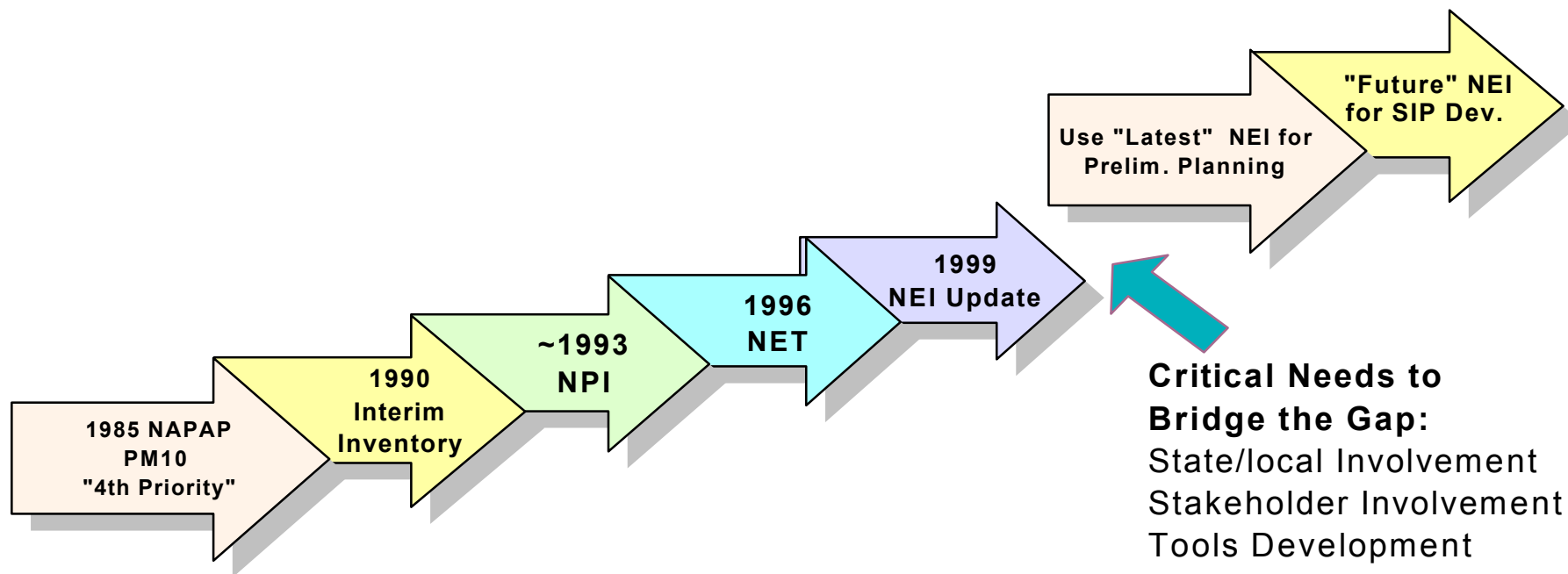
What is the NEI for PM2.5 and its Precursors ?

- **Nat'l tabulation of emissions of PM2.5, SO2, NOx, Ammonia and VOC.**
 - Point sources by Lat-long: 52,000 facilities, each containing multiple emission points. Over 4500 types of processes represented
 - Area & Mobile by County: 400 categories of Highway & Non road Mobile and over 300 categories of Area sources
- **Annual emissions, start / end dates, stack parameters**
- **Estimates for each year (but, some years “grown”)**
- **Also, in the NEI**
 - HAPs emissions for over 6000 more types of processes
- **Currently Available: 1999**

Why have the NEI ?

- **Inventories are Needed to Support:**
 - Federal Emission Standards (Criteria and HAPs)
 - Preliminary Control Strategy Explorations:
 - National Air Toxics Assessment, Residual Risk rules for HAPs, Urban Air Toxics Strategy
 - PM, Regional Haze
 - Tracking Trends
 - Public information Requests
- **The NEI is essential** in planning for attainment of the National Ambient Air Quality Standards (NAAQS)
- **RPO's & State / Local / Tribes** may have more detailed information.

Evolution of EPA's National Emission Inventory



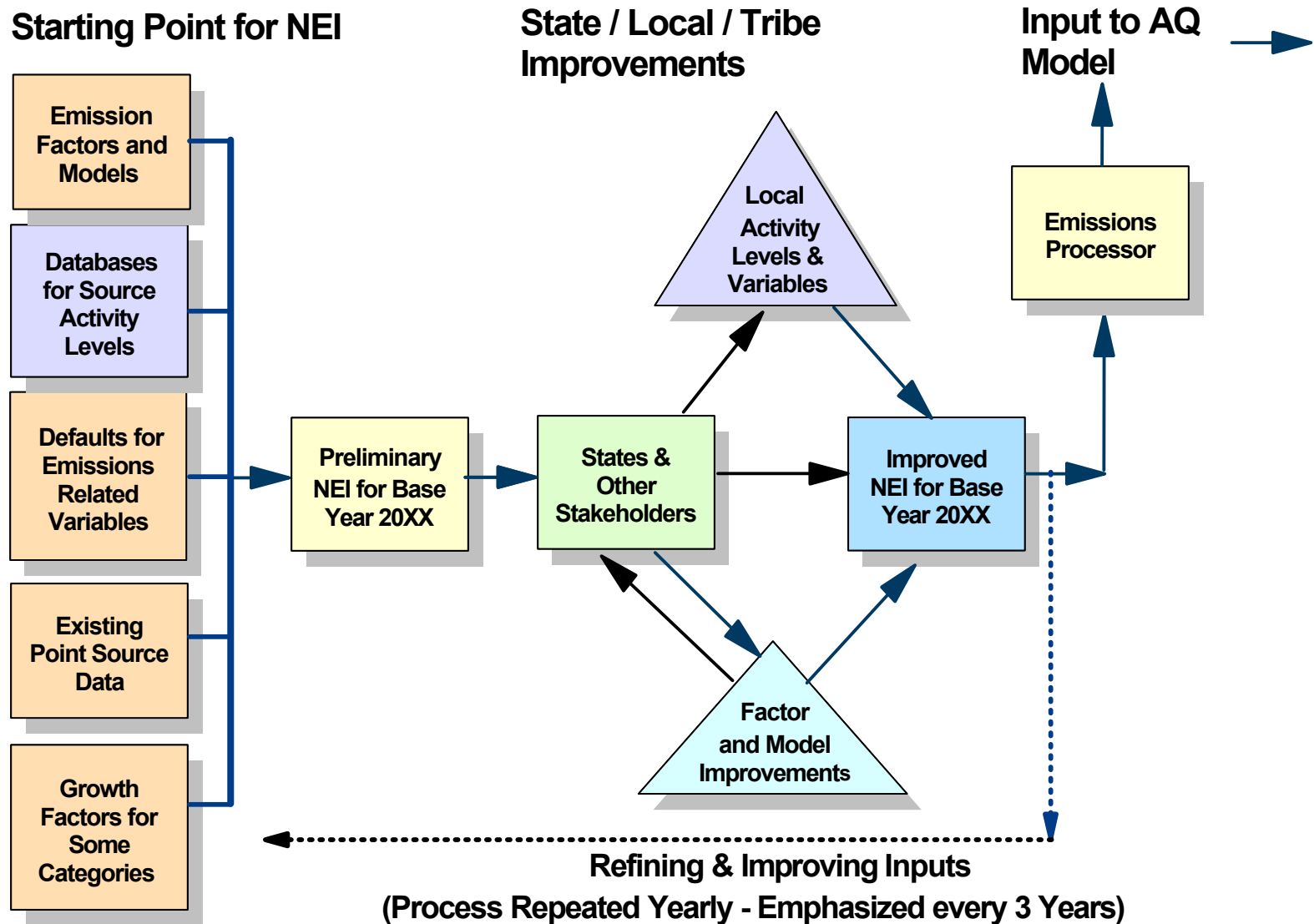
NAPAP - National Acidic Precipitation Assessment Program

NPI National Particulate Inventory

NET National Emission Trends Inventory

NEI Merger of NET and Nat'l Toxics EI

NEI Development ~ Cooperative, Iterative



Development of the 2002 NEI

- **2002 ~ Base year for PM_{2.5} and Regional Haze SIPs**
- **Learn from 1999 experience**
- **Many new factors:**
 - Formal, independent peer review. (First time)
 - CERR & NO_x SIP Call reporting requirements
 - Only one round of state input
 - Fully integrate HAP and criteria within most source categories
 - RPO's will have an important role
 - New OEI data standards
 - Information quality guidelines
- **Version 1 for Criteria Pollutants due out early 2004**
- **Version 2 DRAFT (with non EGU HAPS, State corrections & improvements) due out Fall 2004**

Inventory Preparation Tools

- **Activity Data**
- **Emission Factors**
 - AP-42
 - FIRE (~ 20,000 factors in FIRE)
 - Miscellaneous other references
- **Emissions Models**
 - TANKS
 - NONROAD2002
 - MOBILE6
 - National Mobile Emissions Model (NMIM) – coming soon
 - MOVES – coming later
 - FAA model for aircraft emissions
 - Others (integrated with emissions processing)

Inventory Preparation Tools

- **Activity Data**
- **Emission Factors**
- **Emissions Models**
- **Spatial Locator Aides**
 - GIS
 - GPS
 - Satellites (Photos that give lat/long values)

Inventory Preparation Tools

- **Activity Data**
- **Emission Factors**
- **Emissions Models**
- **Spatial Locator Aides**
- **Emissions Processing**
 - Temporal Allocation
 - Spatial Allocation
 - Emissions Models
 - Speciation Profiles

Emissions Processing Overview

- **NEI ~ Input to the Emissions Processor**
 - ❑ Annual, County-level Inventory
 - ❑ County-to-Grid Allocation Factors
 - ❑ Temporal Allocation Factors
 - ❑ Speciation Factors

- **Emissions Models (Integrated w/ Emissions Processor)**
 - ❑ Biogenics (always)
 - ❑ On-Road (optional)
 - ❑ Fugitive Dust (under development)
 - ❑ Wildland Fire (under development)
 - ❑ Ammonia (in planning stages)

Wildland Fire Emissions Model

(under development)

- **Stand alone or within the CMAQ modeling system**
- **User Inputs:** Fire locations, duration, size
- **Model Components**
 - Fuel loading default: NFDRS (user can override)
 - Fuel Moisture: Calculates using MM5 met data
 - Fuel Consumption: CONSUME2.1
 - Emissions, Heat Release & Plume Rise: EPM & Briggs (modified)
- **Outputs:** Gridded (1- 36 km) hourly emissions, plume characteristics
- **Integrate, Test & Release Module (mid 2004 earliest)**

Fugitive Dust Emissions Model

(under development)

- **Fugitive Dust Emissions Module to work within the CMAQ modeling system:**
 - establish consistent database of resource info (soil map, land use, vegetation cover, moisture, precipitation, wind speed) for making emission estimates w/in CMAQ modeling system.
 - demonstrate proof-of-concept of emission models for wind erosion and other dust sources,
- **Evaluate the capability of the Fugitive Dust Emissions Module**
 - Sensitivity testing & identify key areas for improvement.
- **Integrate, Test & Release Module (mid 2004 earliest)**

Emissions Processing

- **NEI ~ Input to the Emissions Processor**
 - Annual, County-level Inventory
 - County-to-Grid Allocation Factors
 - Temporal Allocation Factors
 - Speciation Factors

- **Emissions Models (Integrated w/ Emissions Processor)**
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 - Ammonia (in planning stages)

- **Processor Output ~ Regional Modeling Input**
 - Gridded inventory
 - Temporally resolved (hourly)
 - Speciation of Primary Emissions (EC, Organics, SO₄, Nitrates)

Speciation of EC & OC

■ EC, OC

- Derived *within the Emissions Processor* from PM2.5 using speciation profiles

■ **Speciation Profiles** ~ estimate of the EC & OC portion of each PM2.5 source's emissions

- All PM2.5 sources “assigned” to 1 of 73 “profiles”
- 64 of 73 profiles contain EC or OC
- Current project to update...
 - profiles assigned to categories in emissions processor, and
 - database of receptor modeling source profiles

Uncertainties in the Inventory

- **Varies Among Pollutants & Source Types**
- **NARSTO** ~ provides *qualitative* assessment
- **Range of Certainty**
 - **SO₂** (best) ... **open sources** (least)
- **Examples of Inventory Issues Contributing to Uncertainty**
 - **PM_{2.5}: Open Burning**
 - Activity Patterns, Fuel Type & Consumption, Smoldering vs Flaming
 - **PM 2.5: Fugitive Dust**
 - Activity Patterns, Soil Characteristics
 - **Ammonia**
 - Mobile Sources, Agricultural Operations
- **Reducing Model / Inventory-induced Uncertainty**
 - **Speciated Rollback**
- **Independent Assessment Using Receptor Models**

Key Issues in PM2.5 Inventory

- **Near-source Removal processes**
 - Crustal Materials, Ammonia
- **Source Activity Data**
 - Unpaved Roads, Open Fires, Residential Burning (waste & wood)
- **Natural Sources**
 - Biogenics, Geogenic wind erosion
- **Spatial & Temporal Allocation**
 - County to grid; Annual to daily, hourly
- **Speciation Issues**
 - Carbon ~ EC / OC Split & OC to Organic Compound Conversion
- **Receptor Models**
 - Carbon ~ Fossil vs Contemporary; Gas vs Diesel; Smokers; Cold Starts
- **Representativeness of Emission Factors**
 - Especially Industrial Processes
- **Process Models & Meteorology, Climatology Effect on Emissions**
 - Fire Emissions, Fugitive Dust, Ammonia from CAFO's & Soils

Preparing 2002 Regional PM_{2.5} Emission Inventories

Improving PM_{2.5} Inventories

Strategy for a Better Inventory ~ 2002

- **Establish priorities** - where can you make a difference?
- **Identify “opportunities” by comparing:**
 - Transport / transformation model results
 - Speciated ambient measurements
 - Apply source apportionment tools
 - Tracer compounds and physical properties
 - Data analytic techniques: UNMIX, PMF, CMB, MLR
- **Leverage resources** by working together
 - Other States, Tribes, RPO's
 - Source Operators
 - Stakeholders
- **Pick your battles!** - Resources are limited

PM Area Source Inventory

Where S/L/T can make a difference

Area Sources are:

Combined emissions of small, ubiquitous, “anonymous” sources w/ similar emission characteristics

- **Many “opportunities” will be available for:**
 - Fugitive Dust
 - Combustion
 - Ammonia
- **Types of “opportunities:**
 - Temporal Patterns of Source Activity
 - Amount of Source Activity (such as: VMT, Fire acreage, Soil Characteristics)
 - Identification of Specific Events (such as: Fire occurrence, Windstorms)
 - Current Regulations & Control Practices (open burning)

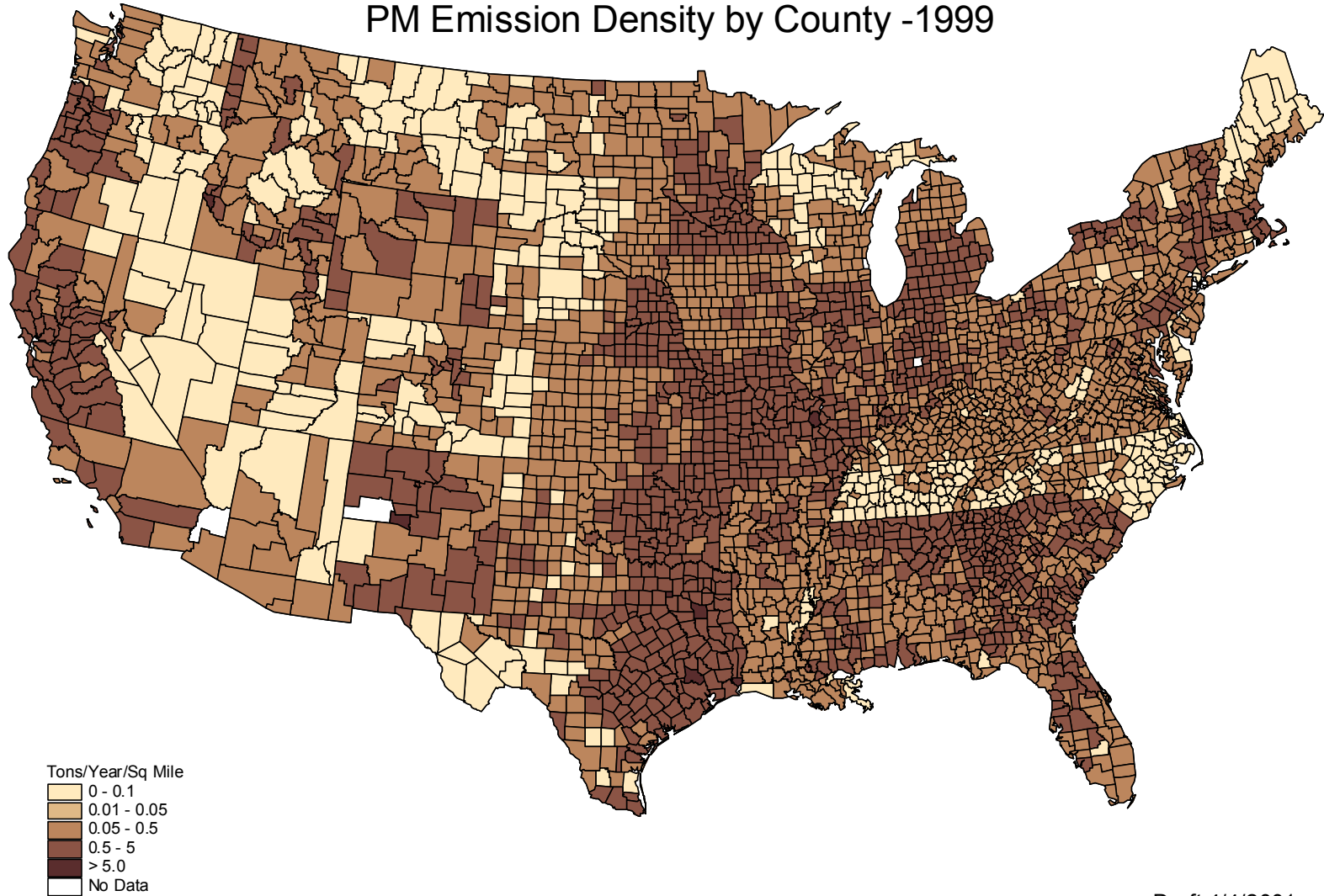
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Opportunities for Inventory Improvements
Fugitive Dust
(Crustal Materials)

Specific PM Dust Categories Most Needing Federal / State / Local / Tribe Improvements

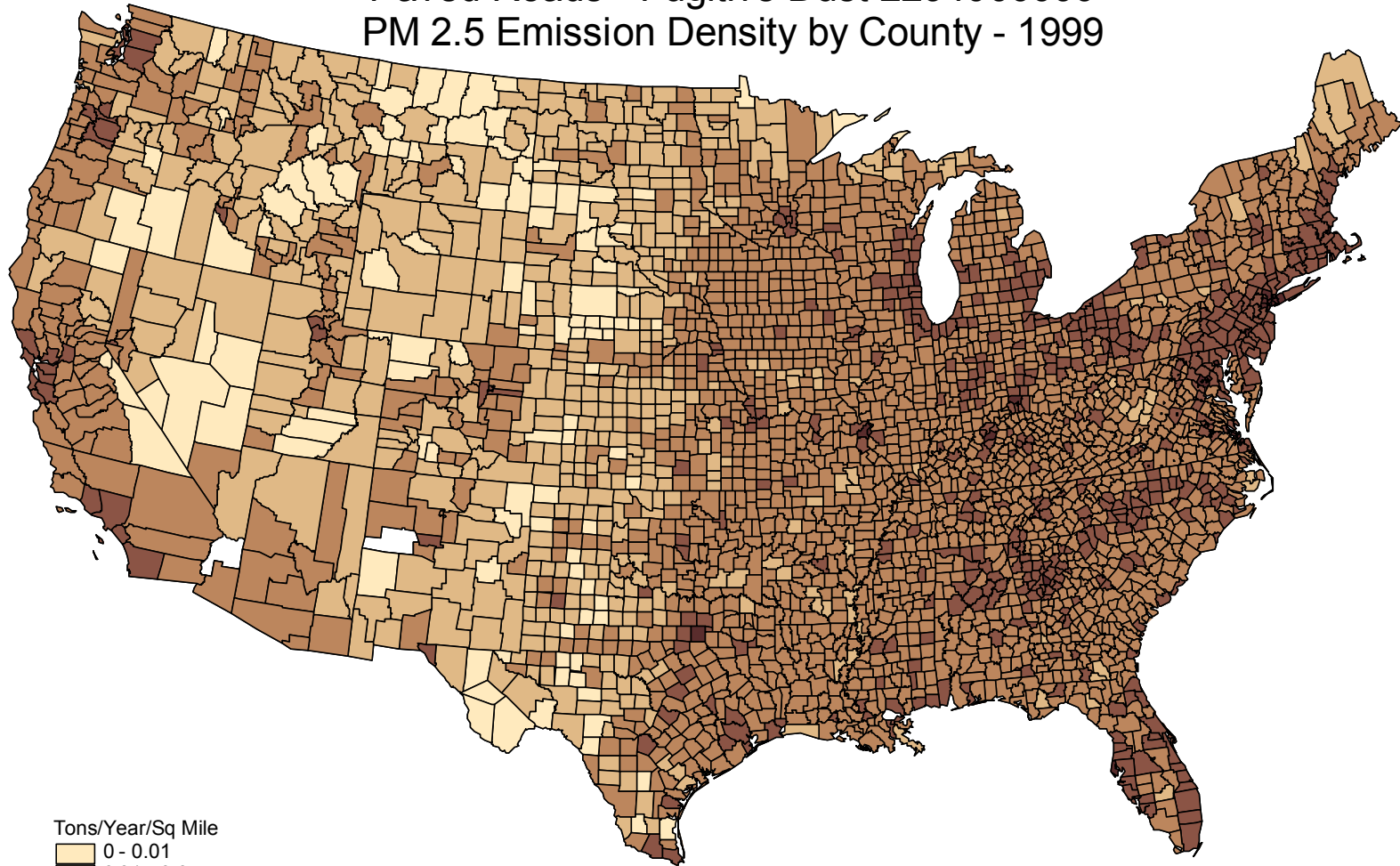
- **Unpaved Roads**
 - VMT, vehicle speeds, surface moisture, silt content
- **Paved Roads**
 - Timing of road sanding events
- **Construction** (*Highway, Residential, Commercial*)
- **Agricultural Tilling**
 - Local tilling practices, crop calendars
- **Mining & Quarrying**
 - Local production & schedules
- **Wind Erosion**
 - Identify occurrence & document high wind events

Unpaved Roads - Fugitive Dust 2296000000 PM Emission Density by County -1999

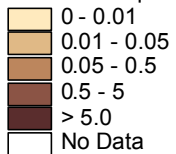


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Paved Roads - Fugitive Dust 2294000000
PM 2.5 Emission Density by County - 1999

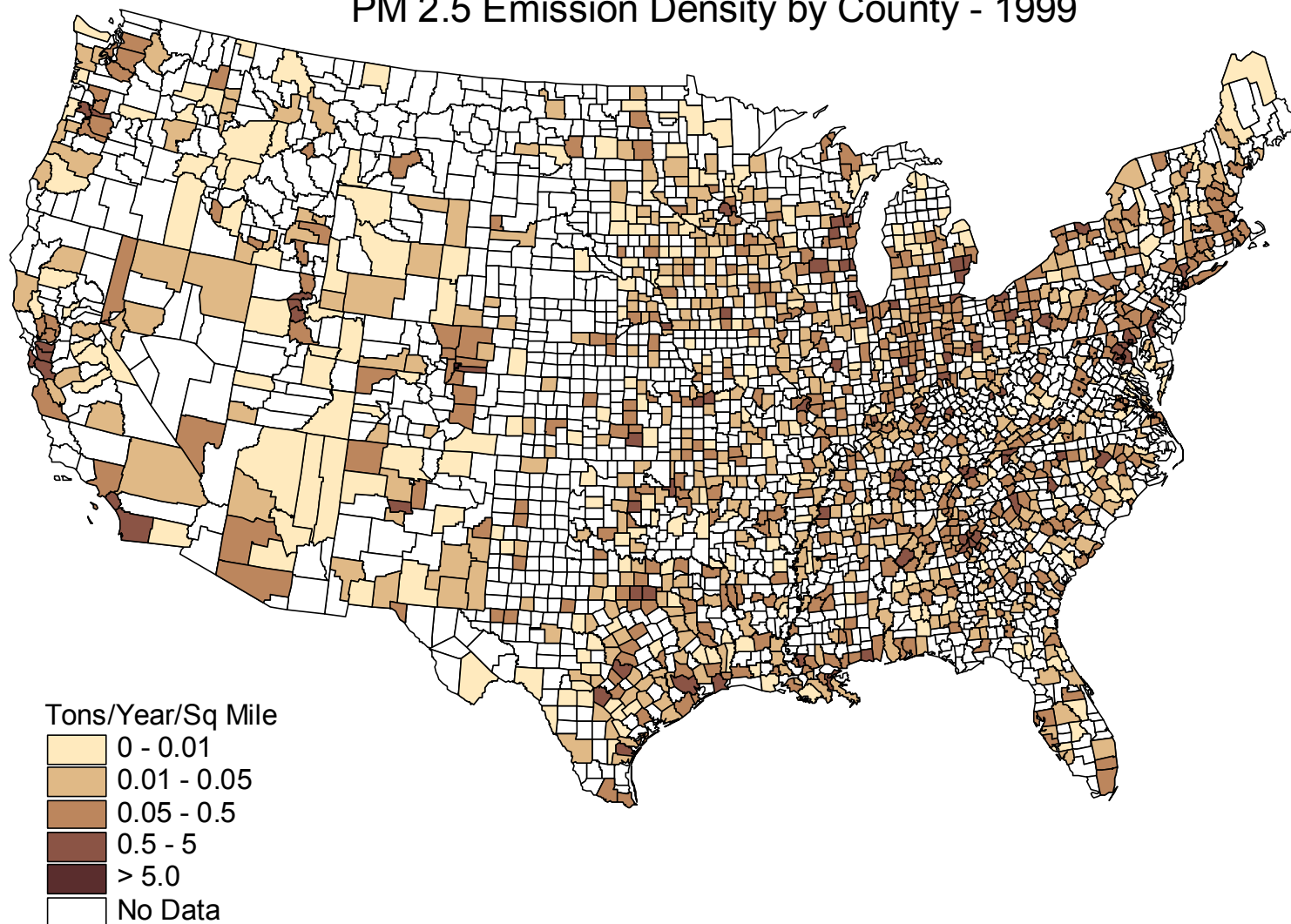


Tons/Year/Sq Mile



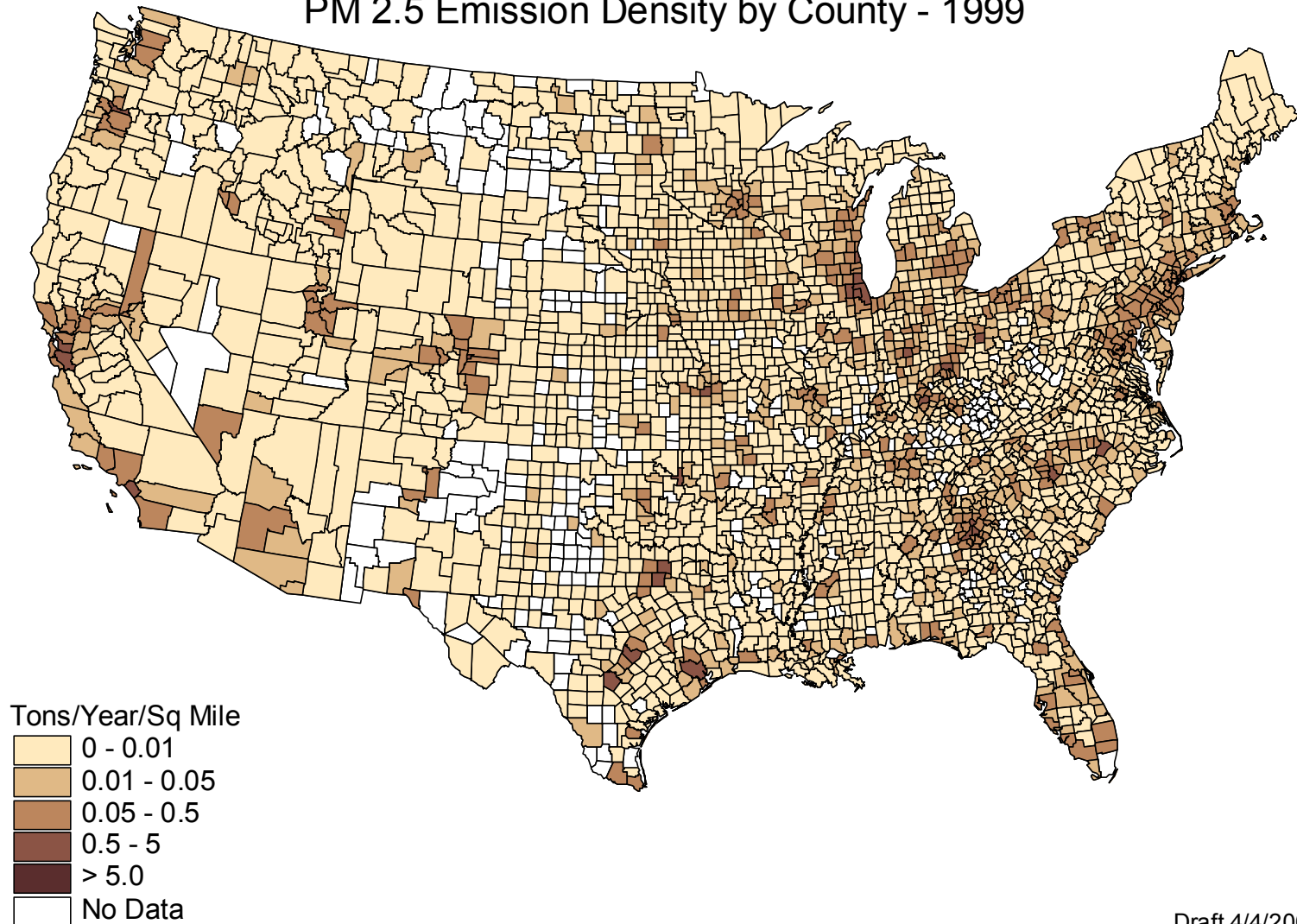
Draft 4/4/2001

Construction Fugitive Dust (Commercial) 2311010000
PM 2.5 Emission Density by County - 1999



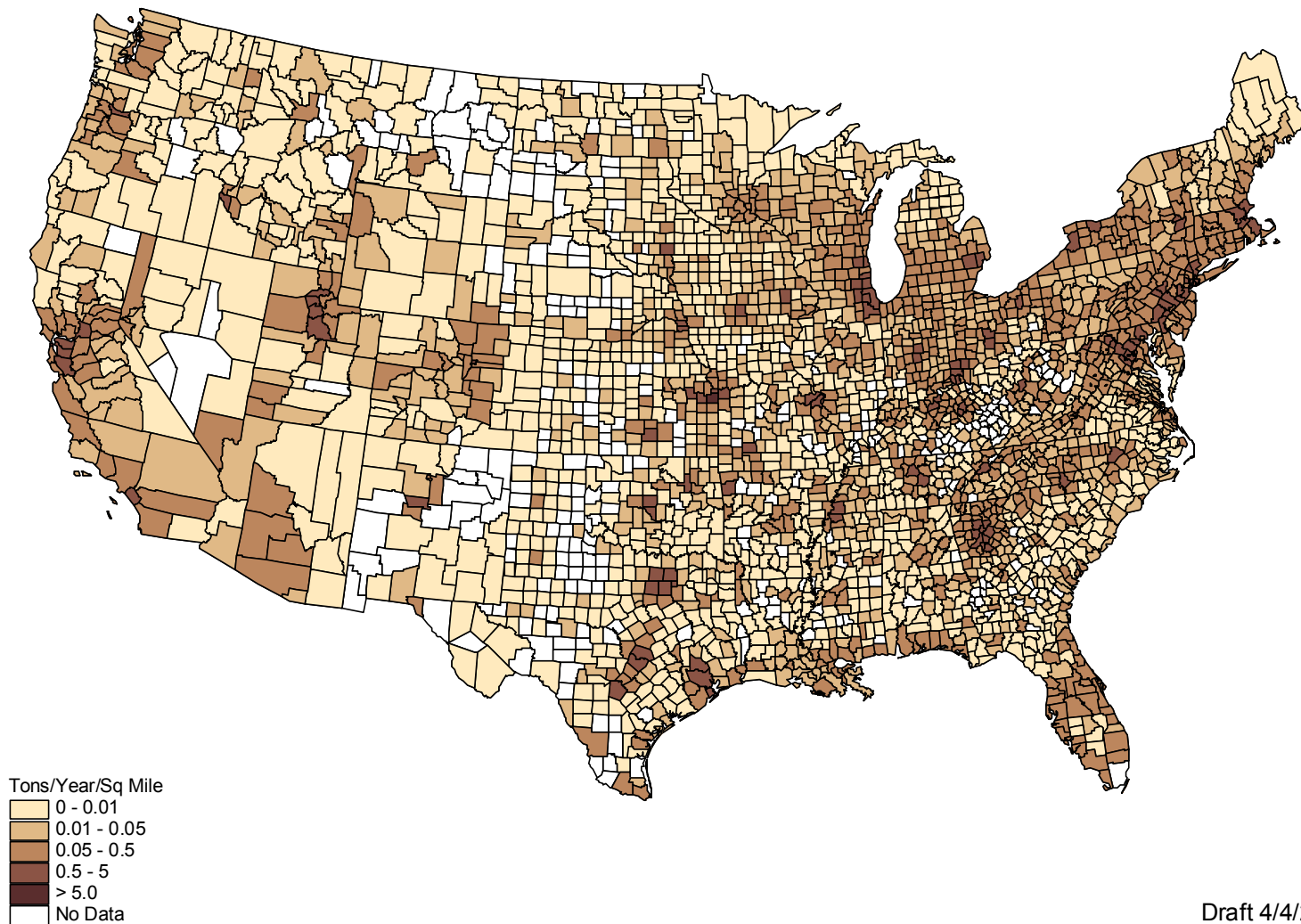
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Construction Fugitive Dust (Residential) 2311010000
PM 2.5 Emission Density by County - 1999



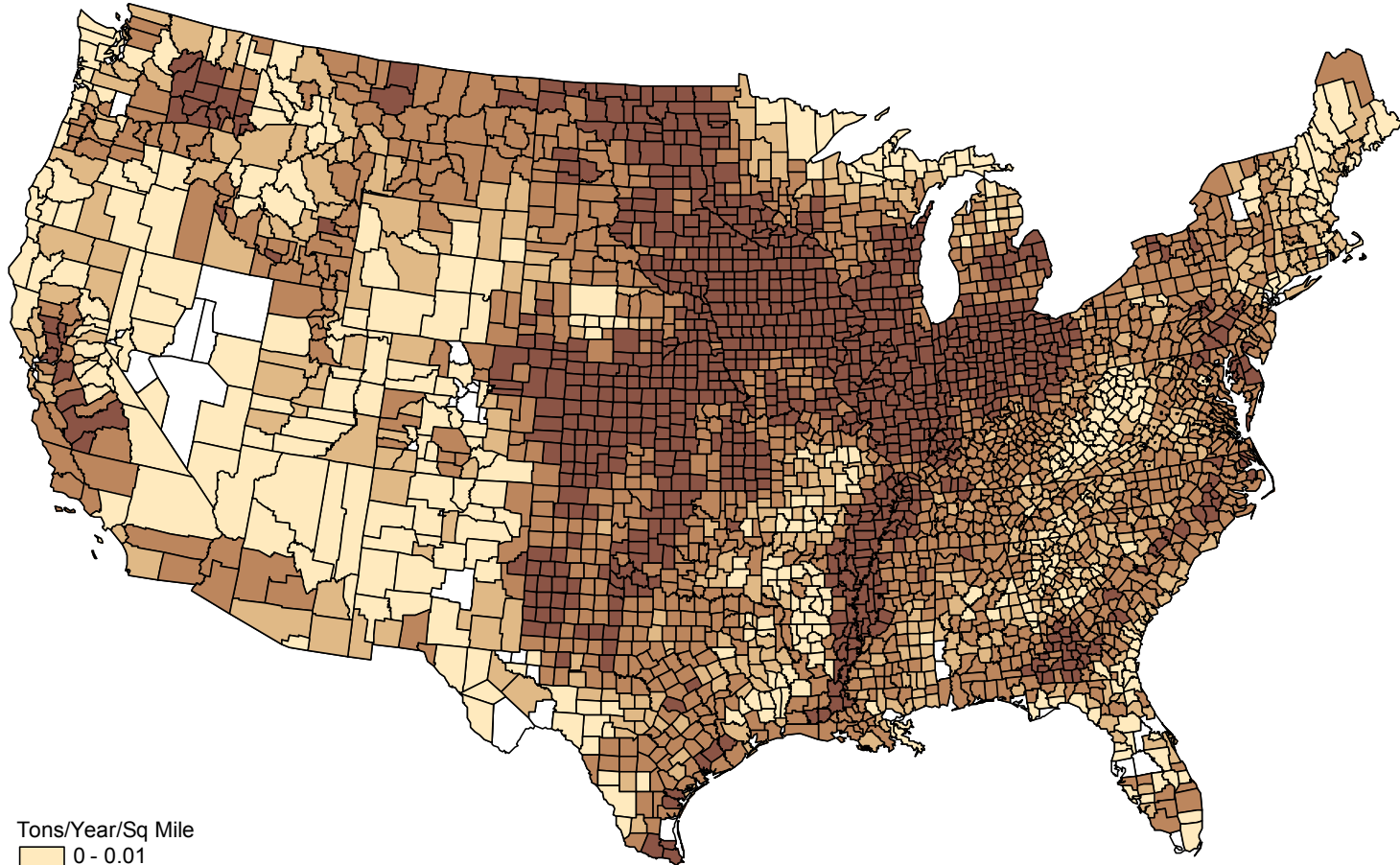
Draft 4/4/2001

Construction Fugitive Dust (Roadway) 2311030000
PM 2.5 Emission Density by County - 1999



Draft 4/4/2001

Agricultural Tilling - Fugitive Dust 2801000003
PM 2.5 Emission Density by County - 1999

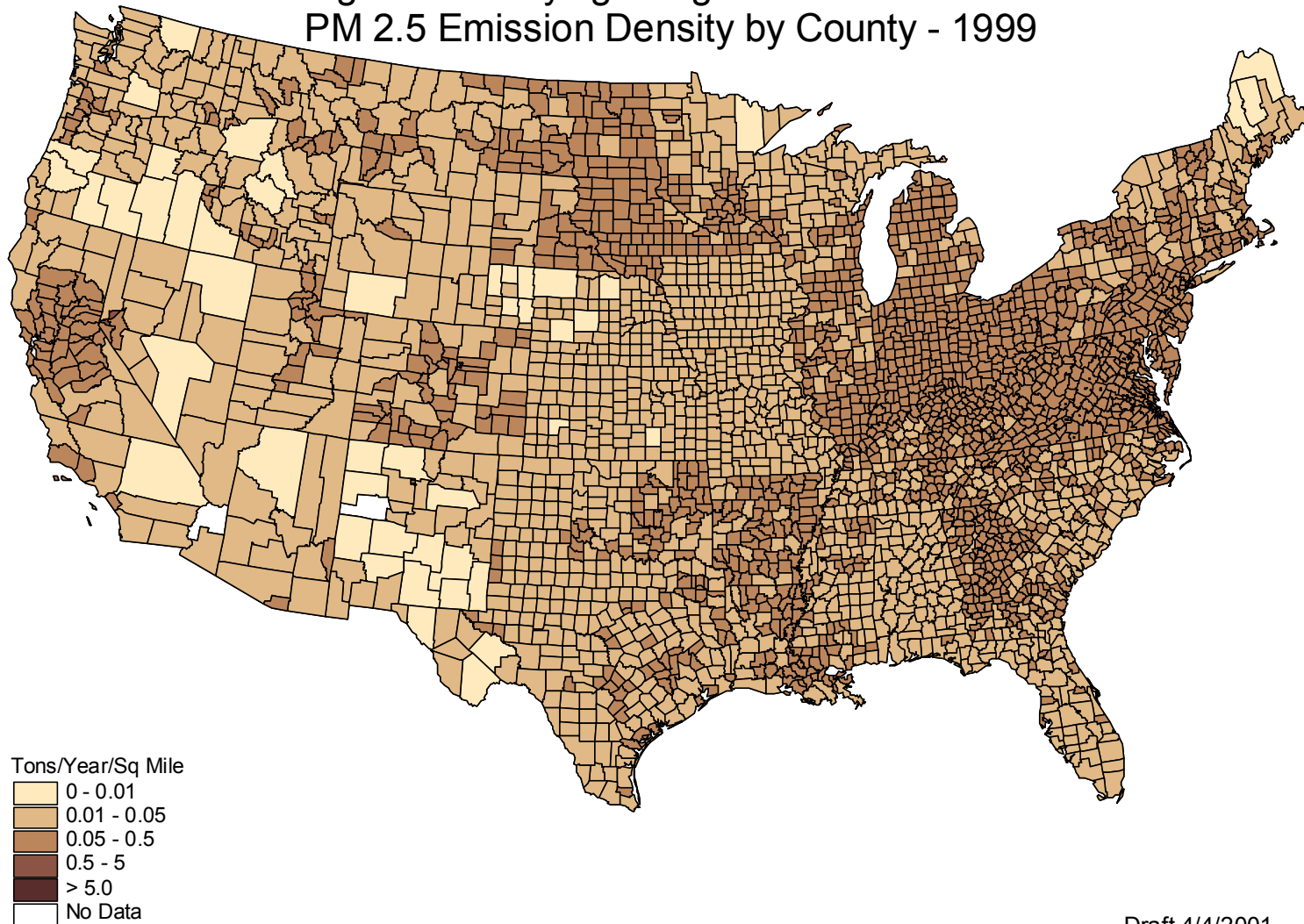


Tons/Year/Sq Mile

0 - 0.01
0.01 - 0.05
0.05 - 0.5
0.5 - 5
> 5.0
No Data

Darft 4/4/2001

Mining and Quarrying - Fugitive Dust 2325000000
PM 2.5 Emission Density by County - 1999



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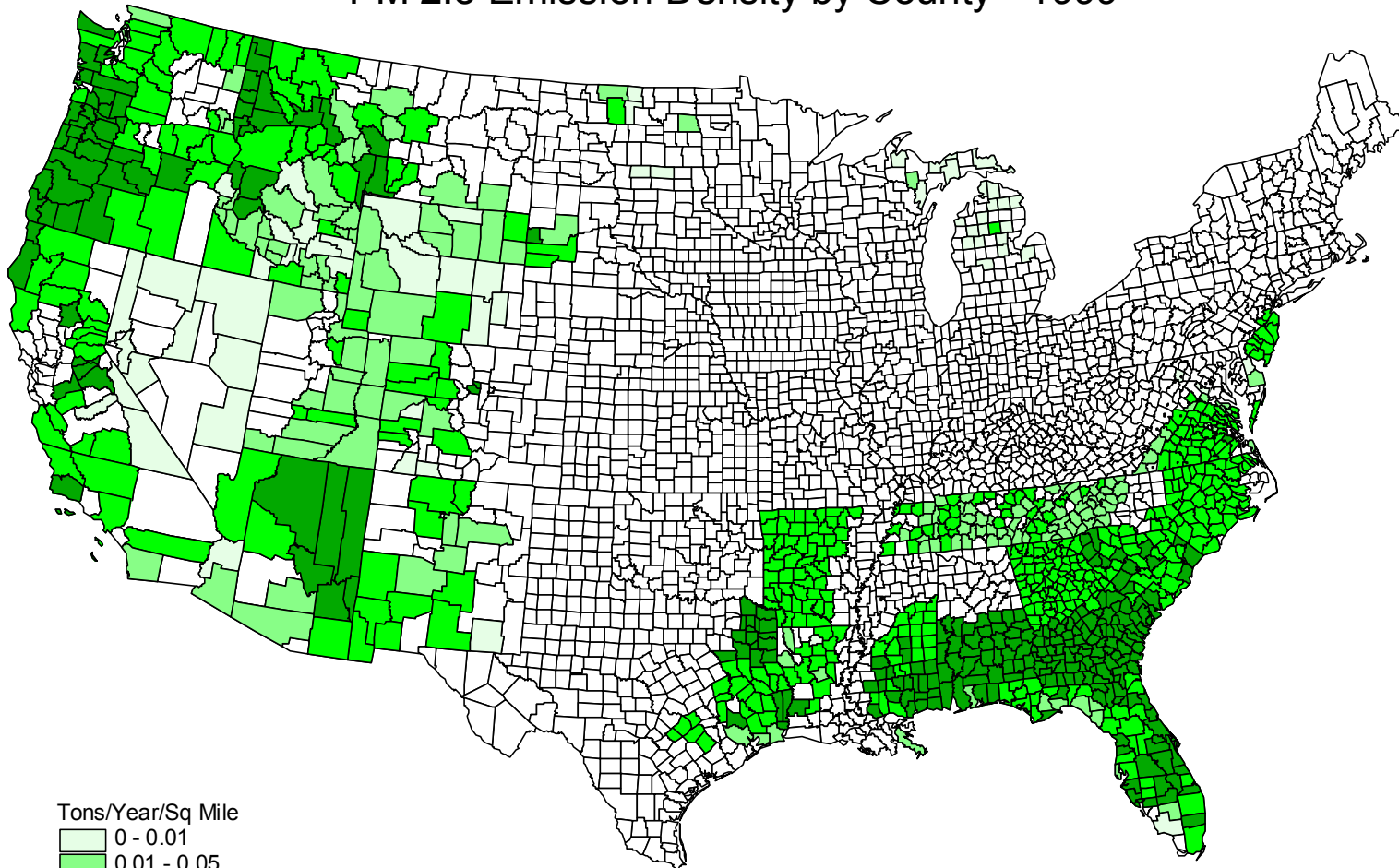
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Opportunities for Inventory Improvements
Combustion

Specific PM Combustion Categories Most Needing Federal / State / Local / Tribe Improvements

- **Wildland Burning** (*Forests, Rangeland*)
 - *(acreages burned, fuel loadings for largest fires, timing)*
- **Residential Open Burning** (*Household Waste, Yardwaste*)
 - *Regulations & their effectiveness, local surveys of burn activities)*
- **Construction & Logging Slash**
 - *Regulations & their effectiveness, local surveys of burn activities*
- **Agricultural Field Burning**
 - *Acreages, fuel loadings, timing*
- **Residential Wood Combustion** (*Fireplaces, Wood Stoves*)
 - *local surveys of fuel burned, fireplace vs wood stoves, adherence to local regulations*

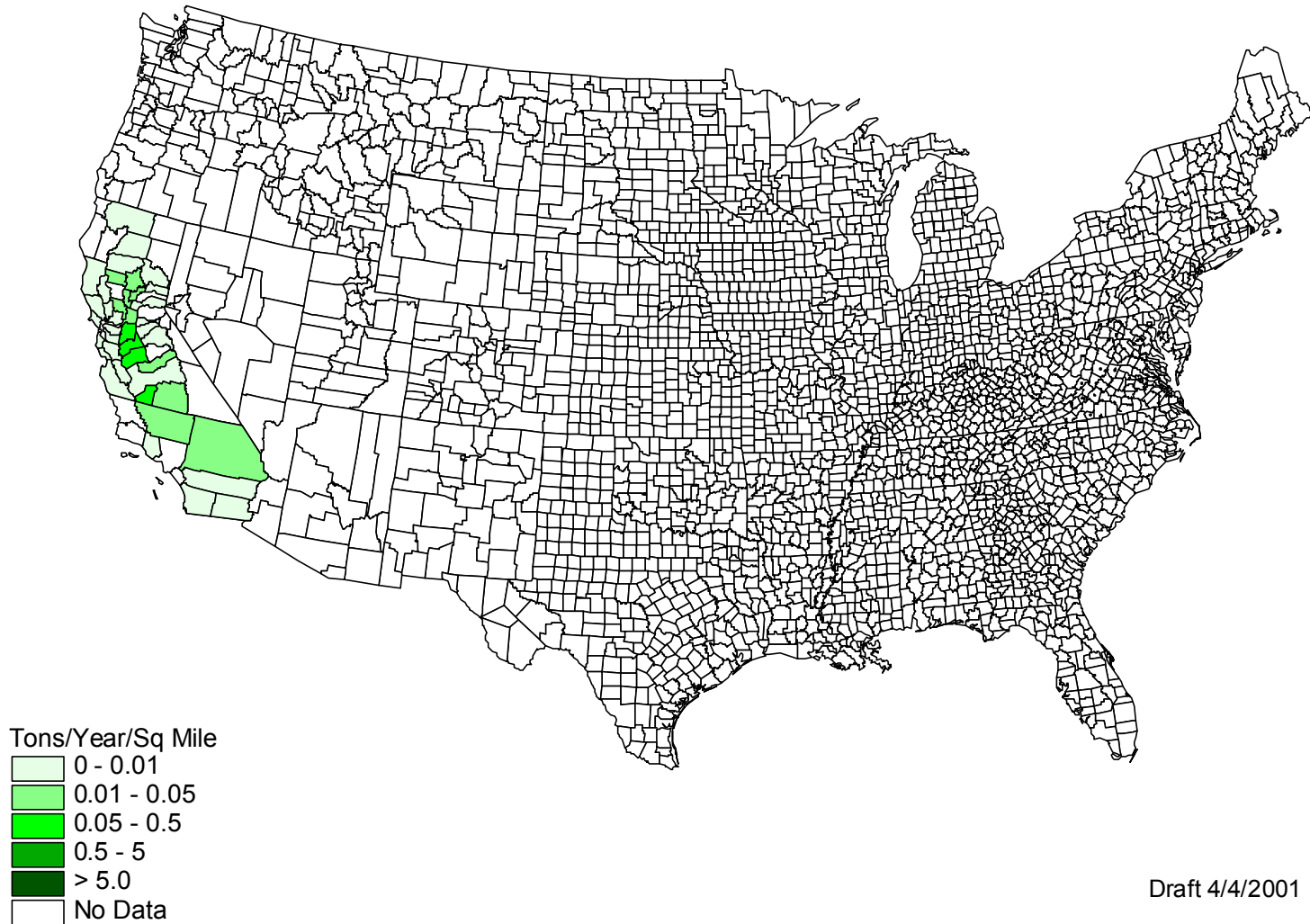
Managed Burning-Prescribed 2810015000
PM 2.5 Emission Density by County - 1999



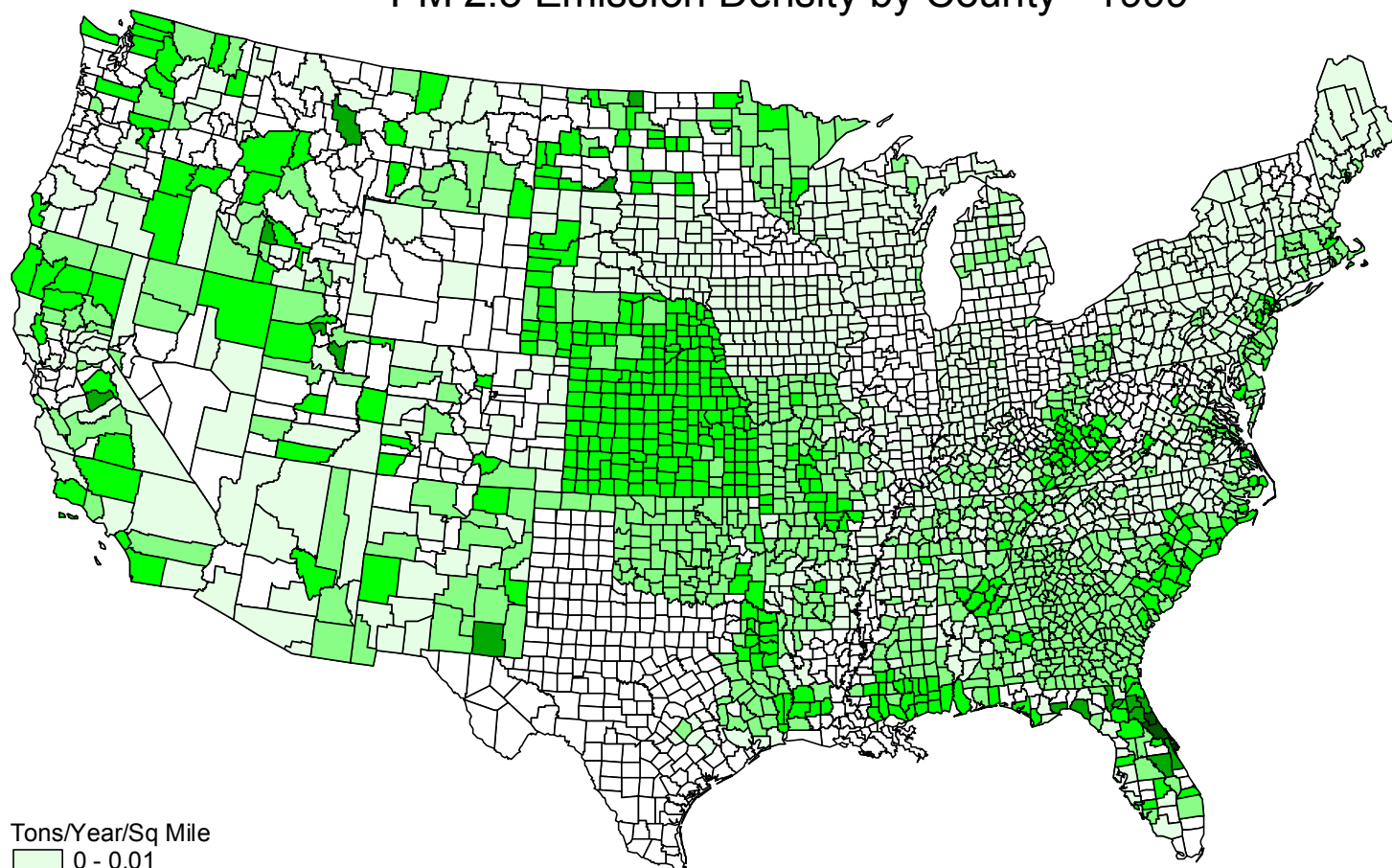
Tons/Year/Sq Mile
0 - 0.01
0.01 - 0.05
0.05 - 0.5
0.5 - 5
> 5.0
No Data

Draft 4/4/2001

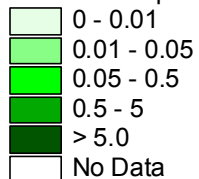
Managed Burning (Slash) 2810005000
PM 2.5 Emission Density by County - 1999



Wildfires 2810001000
PM 2.5 Emission Density by County - 1999



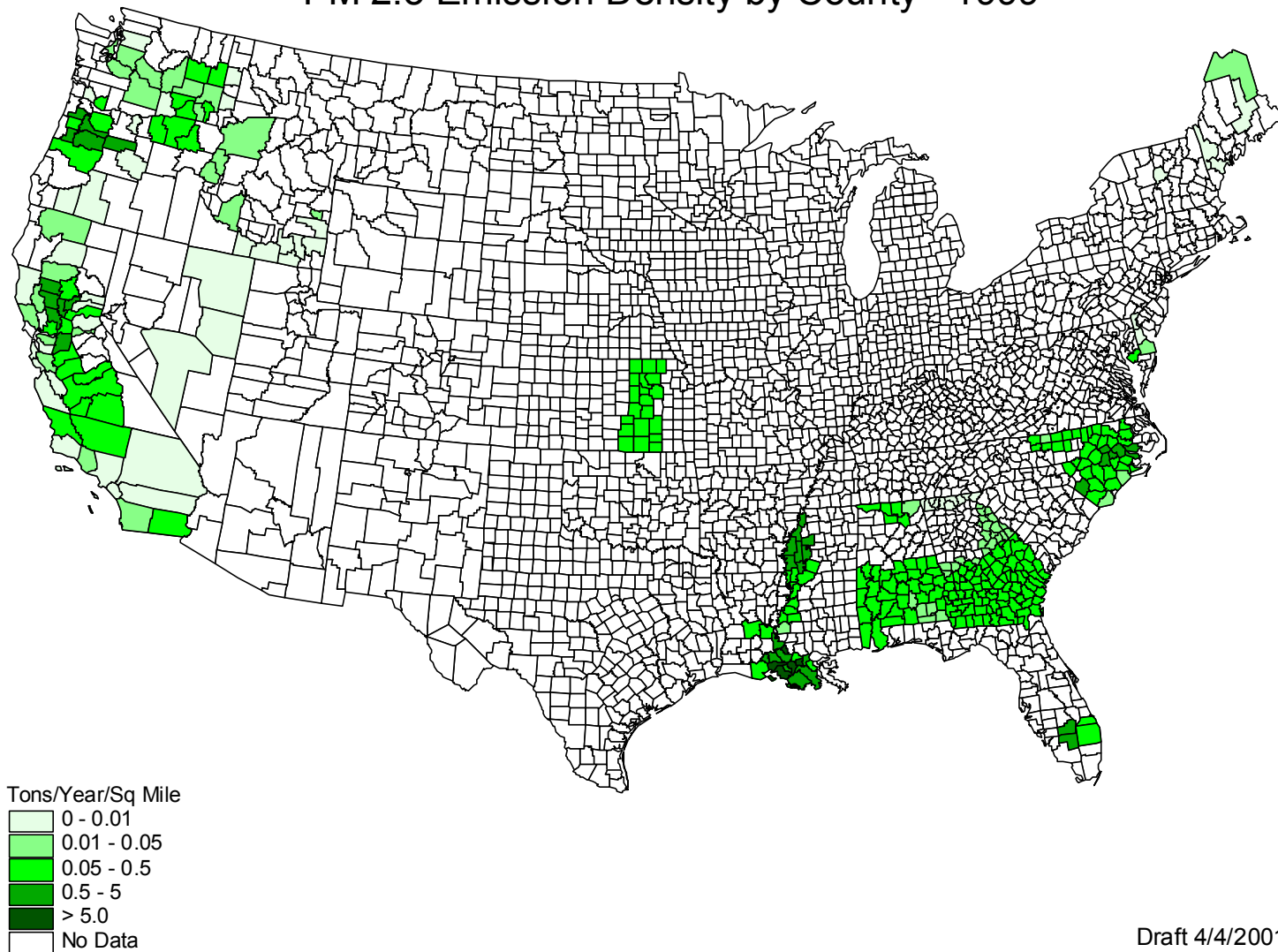
Tons/Year/Sq Mile



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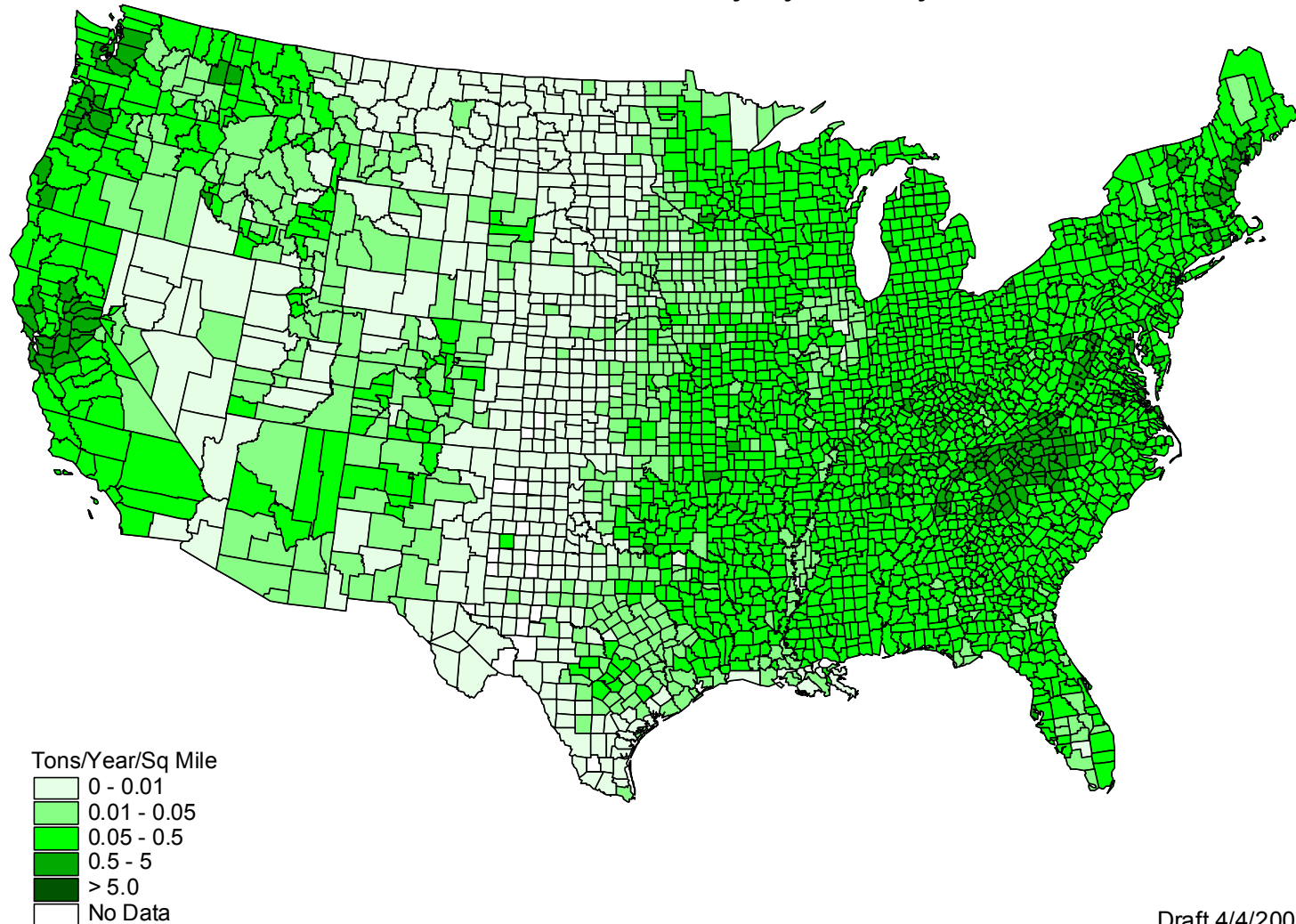
Ag Field Burning 2801500000

PM 2.5 Emission Density by County - 1999



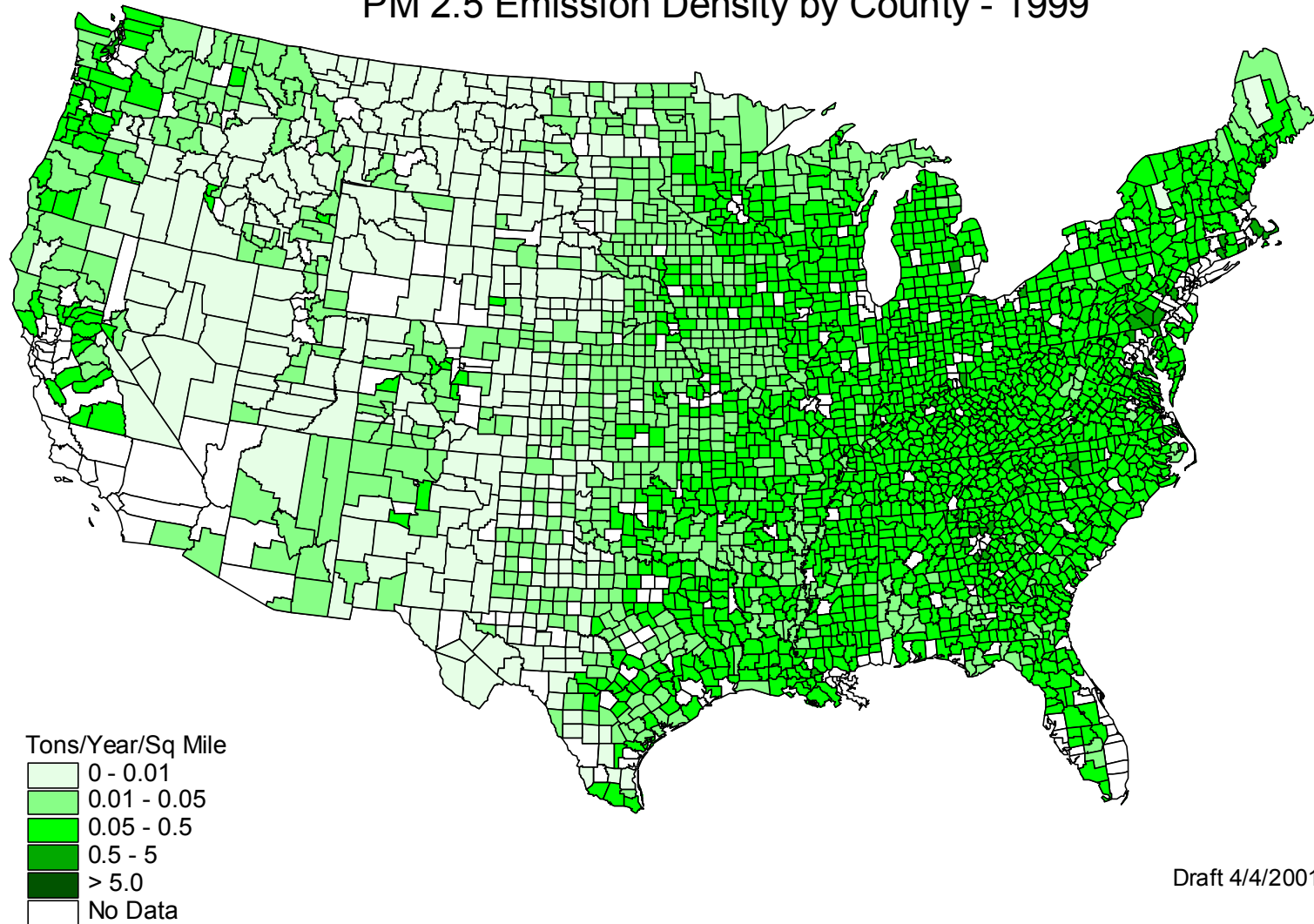
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Residential Wood Fireplaces 2104008001
PM 2.5 Emission Density by County - 1999

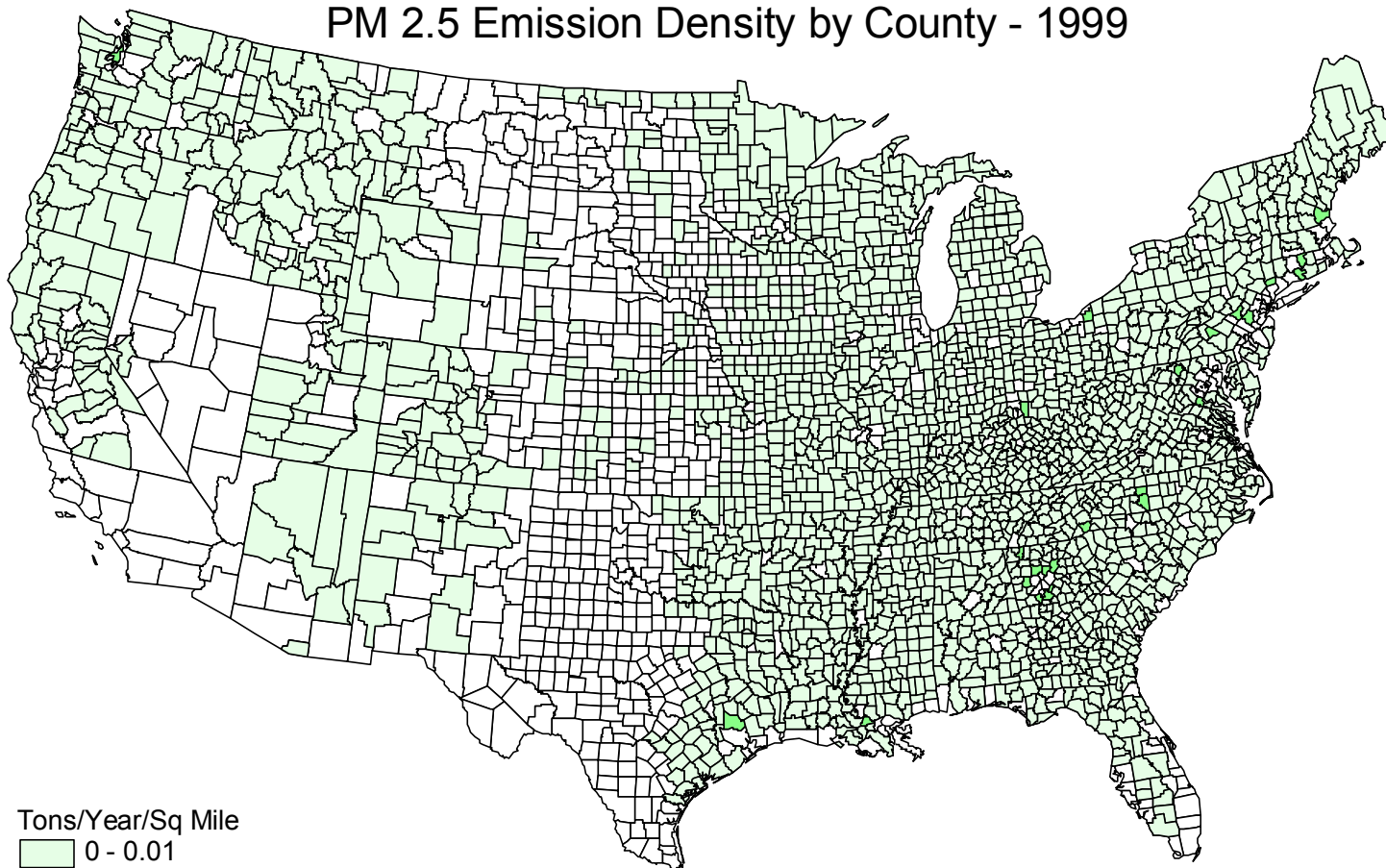


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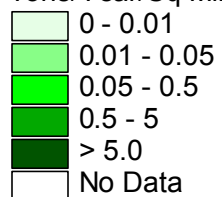
Residential Open Burning (Household Waste) 2610030000
PM 2.5 Emission Density by County - 1999



Residential Open Burning (Brush) 2610000100
PM 2.5 Emission Density by County - 1999

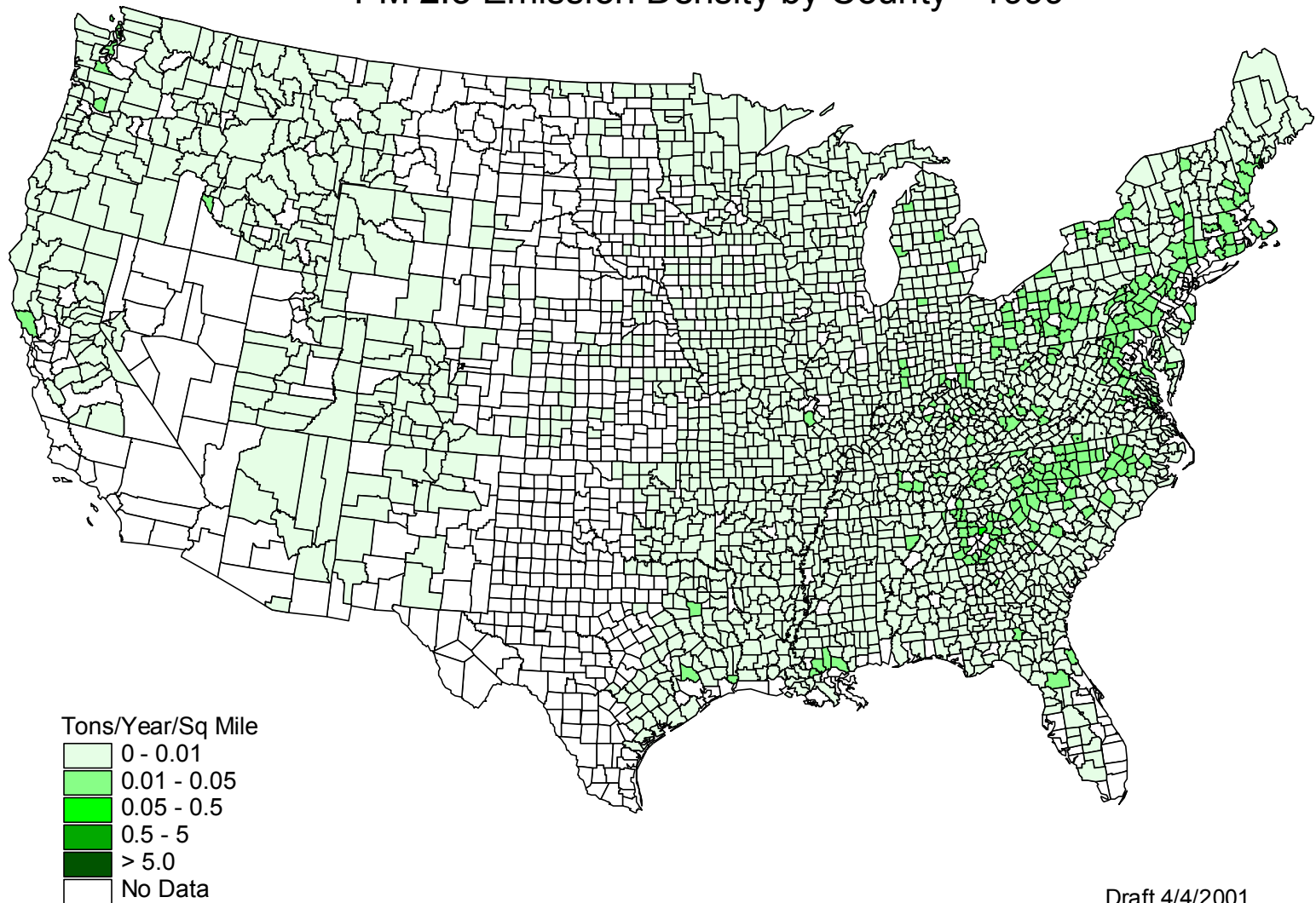


Tons/Year/Sq Mile



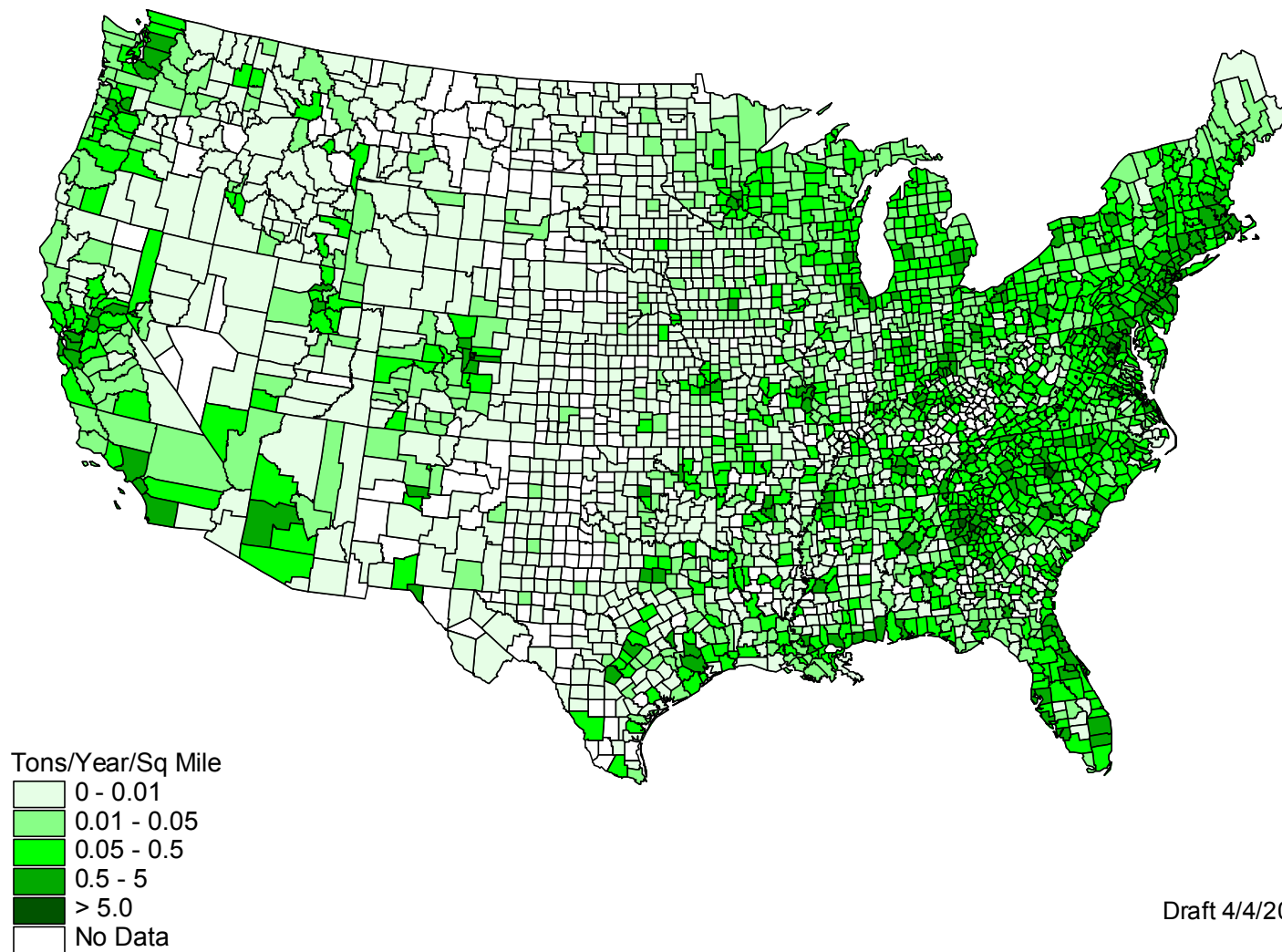
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Residential Open Burning (Leaves) 2610000100
PM 2.5 Emission Density by County - 1999



Draft 4/4/2001

Construction Debris Open Burning 2610000500
PM 2.5 Emission Density by County - 1999



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Opportunities for Inventory Improvements
Ammonia

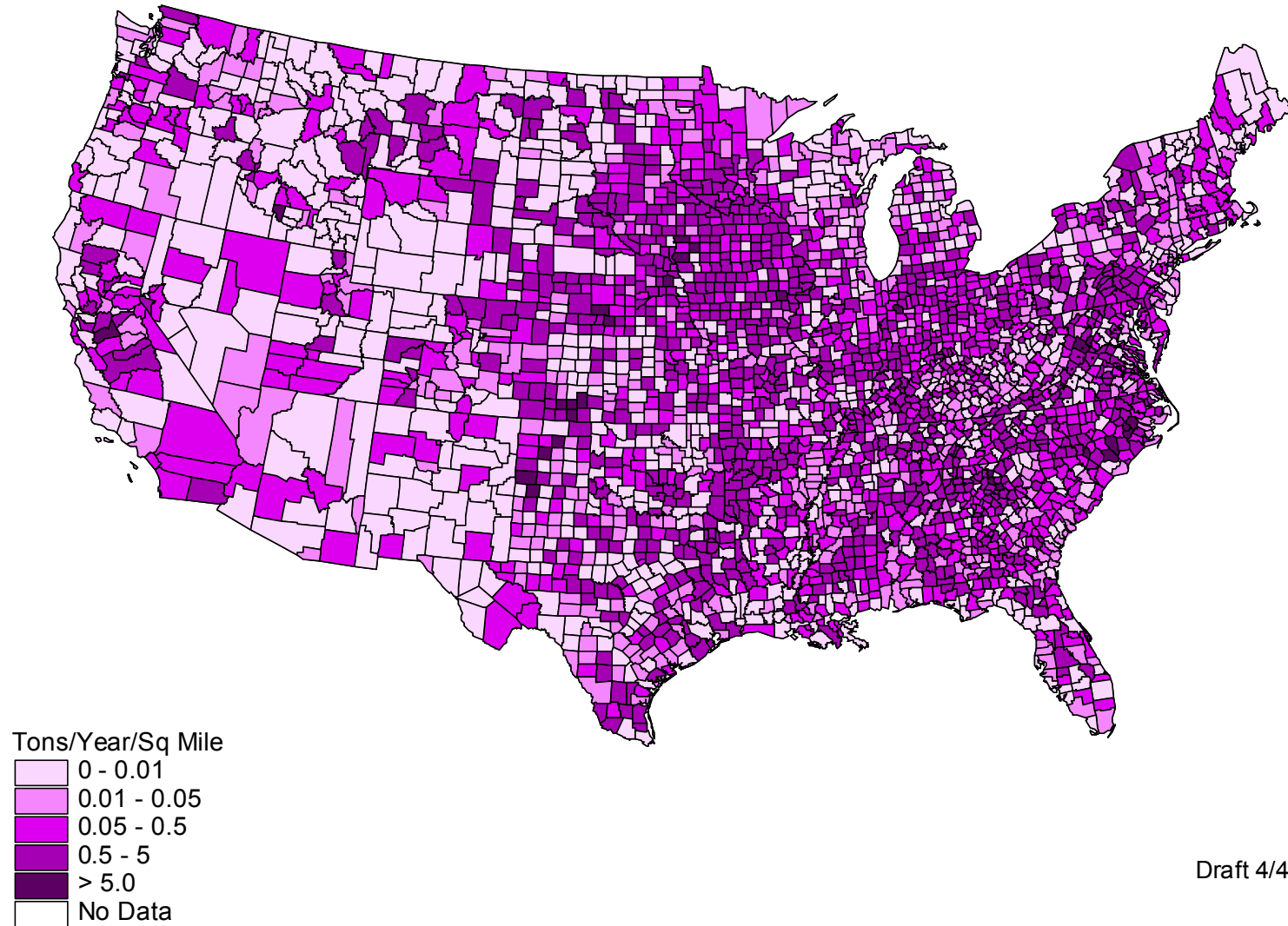
Ammonia - Key Sources & Issues

- **Key categories in current EI**
 - Animal Husbandry (80%)
 - Fertilizer Application (10%)
 - Point Sources (may be large locally), Mobile Sources
- **Missing Sources** (May not all be major sources)
 - Humans, Domestic and wild animals
 - Open burning
- **Soils and Vegetation**
 - Can be source or sink -- Work ongoing: TX, CA, EPA/ORD
- **Ammonia is Important to AQ Analyses**
 - Involved in formation of Sulfate, Nitrate
 - SO₂, NO_x may be subject to regulation

Agricultural Ammonia

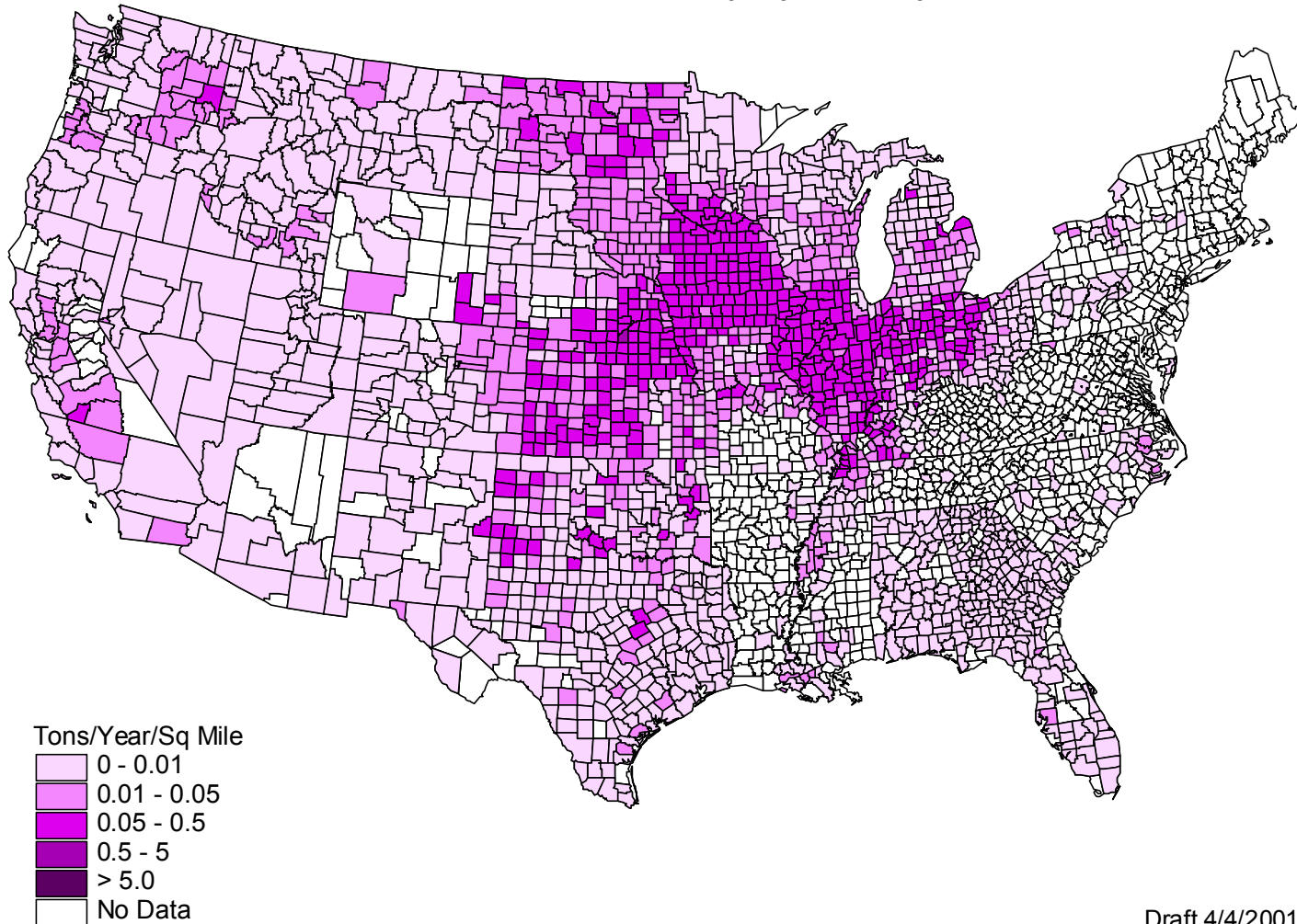
- Higher Priorities:
 - Animal Types
 - Beef Cattle, Dairy Cattle, Hogs, Poultry
 - Animal Size
 - Weight or size class,
 - Animal population (by season)
 - Waste Application & Treatment
 - When & how much sprayed on fields
 - Type of storage & waste system
 - Fertilizer Practices
 - When & How Applied

Animal Husbandry - 2805020000, 2805025000, 2805030000, 2805035002
NH3 Emission Density by County - 1999



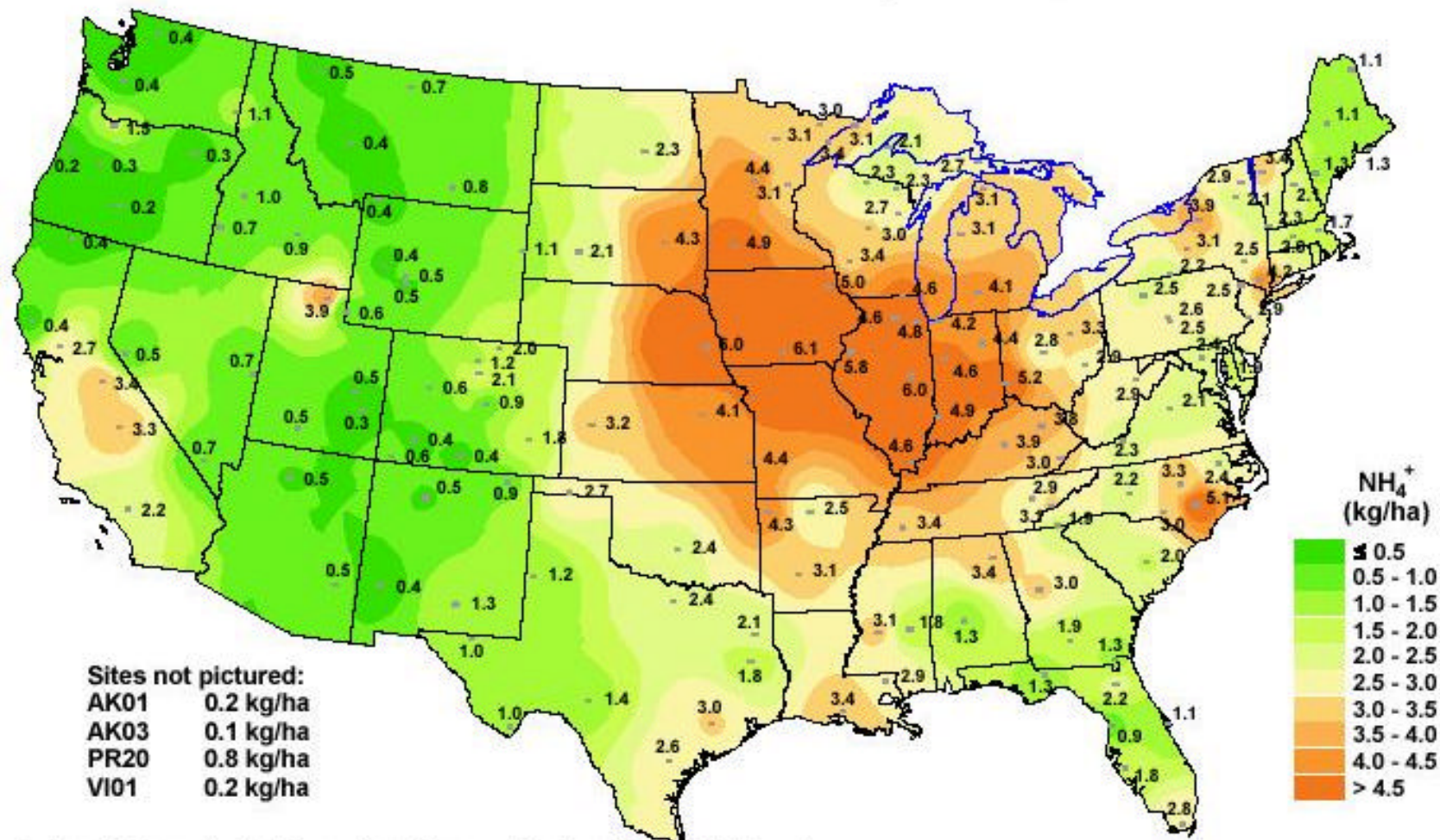
Draft 4/4/2001

Fertilizer Application 2801700001
NH₃ Emission Density by County - 1999



Draft 4/4/2001

Estimated ammonium ion deposition, 1998



National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>

Any More Questions ?

PM2.5 Overview

National & Regional Inventories

Fugitive Dust

Combustion

Ammonia

OAQPS / EFIG Contacts

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919-541-5463

That's All, Folks!

Thanks for Coming !